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A TECHNIC FOR ROENTGENOSCOPIC EXAMINATION OF THE STOMACH AND DUODENUM[1]

By B. R. KIRKLIN, M.D., *Rochester, Minnesota*

Section on Roentgenology, The Mayo Clinic

THE necessity of employing a methodical technic for making roentgenoscopic examination of the stomach and duodenum need not be argued. Even if an orderly routine were unnecessary, force of habit would induce the adoption of a set procedure by every examiner. Notwithstanding an identity of aims, however, technics of individual roentgenologists vary widely. Uniformity in procedure is not to be expected, but the diversity in methods might be lessened, and even the best of them might be improved by more frequent discussions of the subject. I propose, therefore, to describe a routine that has been followed at the Mayo Clinic for several years and that has proved to be practicable, efficient, and capable of rapid execution. I am not urging that it be adopted in its entirety by anyone, but I hope that consideration of its rationale will stimulate other roentgenologists to devise technics that will be better than my own. This method bears no claim to originality, for fundamentally it is that used by Carman, with such additions and modifications as seemed desirable. Carman received his inspiration and guidance largely from Holzknecht and Haudek, who in turn were influenced by other European roentgenologists, for at one period Europe led the world in applying roentgen rays to the diagnosis of gastro-intestinal disease. But it must not be forgotten that two Americans, Williams and Cannon, were among the first, if not the first, to make fluoroscopic examination of the human stomach after filling it with a harmless opaque medium.

At the beginning, the primary objectives of the examination were to determine the general form, size, and position of the alimentary canal; the contours of its lumen, and the functional behavior of the gastro-intestinal tract. Soon it was learned, however, that when the canal was filled with the opaque medium the luminal profile might appear to be normal despite the presence of small lesions, and that to reveal such lesions it was necessary to obtain surface views of the internal topography by distributing a thin layer of the medium over the mucosa. It was also found that, within wide limits, the size, position, and general form of the canal have little significance. For many years the functional behavior of the alimentary tract was given sharp attention and held a high place among diagnostic signs, but now it is esteemed chiefly for its occasionally suggestive value, and at present virtually all diagnoses are based on the direct exhibition of anatomic changes. To disclose such changes, however slight, is the

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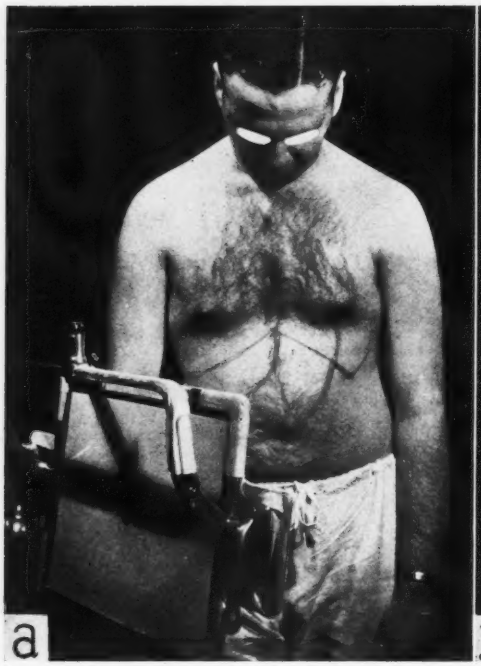

Fig. 1-*A*. Patient of sthenic habitus with abdomen pushed out preparatory to examination of the cardia.

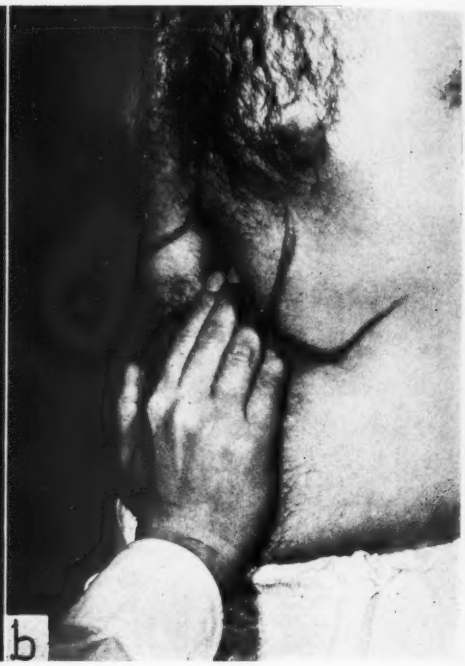

Fig. 1-*B*. Palpating hand in position during relaxing period.

prime purpose of the technic that I shall present.

PREPARATION OF THE EXAMINER

To obtain adequate visual adaptation to darkness the examiner stays in the darkened screen room for some time before beginning his work. Often this preparation requires fifteen minutes, and on bright days an even longer period may be necessary. A means of testing the visual acuity is desirable if not indispensable. I have found that my wrist watch with its luminous hour marks is a reliable test object and that when the numerals become clearly visible my eyes are well adapted. It has long been standard practice for the examiner to wear a soft buckskin glove on his right hand. Most of the manipulations are executed with this hand, and the buckskin glove probably constitutes sufficient protection against the amount of irradiation received. Lately, however, as a further concession to prudence, I have been using a flexible glove impregnated with lead salts in an amount equivalent to the protection afforded by one-tenth millimeter of metallic lead. With this covering the palpating hand is more easily discernible when it intrudes into the irradiated field, and thus the examiner is warned against subjecting it to unnecessary exposure, yet this glove is almost as pliable as one of buckskin and is not at all cumbersome. I do not wish to minimize the factor of protection, and the examiner should use all protective measures that he deems necessary, but avoid so far as possible any that interfere with the process of examination.

PREPARATION AND GENERAL MANAGEMENT OF THE PATIENT

To insure that the patient's stomach will be in the fasting state, so that the roentgenoscopic inspection will not be hampered by retained food or fluid, he is instructed to take neither food nor drink on the day of examination. As patients

Fig. 2-*A*. Same patient as in Figures 1-*A* and 1-*B*. Position of palpating hand and of the cardia at the moment of greatest descent.

Fig. 2-*B*. Cardia has ascended and as a result of the pressure of the examiner's hand the rugæ are depicted.

are examined at the Clinic in the afternoon, because that time is most convenient for all concerned, a fast of approximately twenty hours is entailed. Obviously, this period is longer than necessary, and a fast overnight would be sufficient preparation for examination in the morning. About three-fourths of our patients are sent during the morning by the clinicians for analysis of the gastric contents, and this procedure further assures complete emptying. In cases of obstruction, however, the stomach tube often fails to remove all bits of food. It is noteworthy also that if gastric analysis is carried out shortly prior to roentgenoscopy, an annoying excess of secretion is likely to follow the use of the tube.

Purgatives are not given beforehand, although they are not specifically interdicted. As disturbance of secretory and motor functions may continue for some time after catharsis, I prefer that all purgatives be avoided. However, this point is not highly important, and roentgenologists who are accustomed to examine both stomach and large bowel on the same day are, of course, warranted in prescribing cathartics.

Originally the routine comprised administration of an opaque meal, the so-called six-hour meal, as a test of gastroduodenal motility. To carry out this test the patient is given, instead of breakfast, 60 gm. of barium sulphate in an ordinary portion of well cooked cereal, to which a little sugar and milk, but not cream, are added. At examination six hours later, the stomach should be empty, and a substantial gastric residue, if no other food has been taken meantime, is usually indicative of disease of the stomach or duodenum. Occasionally, however, retention results from reflex or functional disturbances, and is a frequent accompaniment of migraine. Further, the presence of a considerable residue interferes with exhibition of the internal relief. For these reasons I have abandoned employment of the six-hour meal as a routine. But to advise others to dispense with it might be a disservice, for the presence of a residue

Fig. 3-*A*. Posture usually assumed by patient after drinking the barium and after the mug has been taken from his left hand; he is erect, his head is against the panel, his left arm raised, and his abdomen is rigid and retracted. It is impossible to examine a patient in this pose.

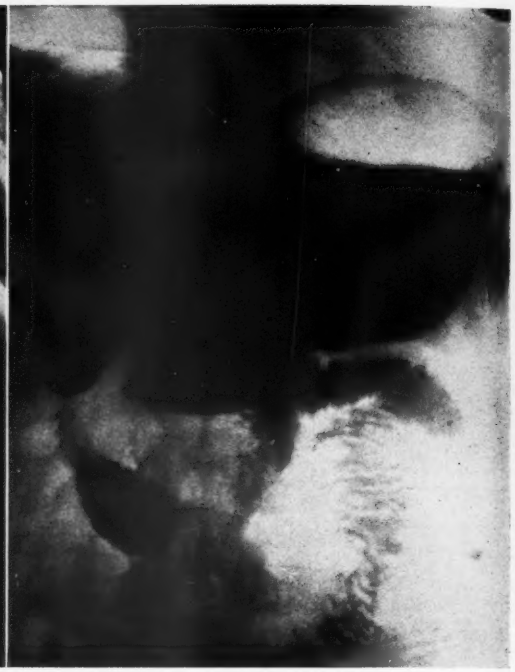

Fig. 3-*B*. Roentgenogram of the stomach taken while the patient was in the position described in Figure 3-*A*; the stomach lies high under the costal arches and is not accessible for manipulation

stimulates thorough search for its cause, furnishes corroborative evidence when organic changes are hard to discern, and, when it is the result of obstruction, is an index of the degree of obstruction.

Especially to be emphasized is the necessity of having the patient in a thoroughly relaxed state during the process of examination. This passivity is absolutely requisite to secure the pliability of the abdominal wall that is essential for satisfactory manipulation of the stomach and duodenum and to promote normal evacuation of the barium through the pylorus, so that the duodenum will be adequately depicted. Nervous tension from any cause commonly gives rise to rigidity of the abdominal muscles, upward retraction of the stomach, and spasticity of the pyloric sphincter. Unpleasant emotions, especially fear and anger, often induce such defensive reactions, and pinching or too vigorous massage of the abdominal wall while executing palpatory maneuvers will almost certainly make the patient a difficult subject for examination. Examiners who become acquainted with their patients prior to the examination are less likely to have trouble from some of the psychic causes of agitation, but at the Clinic patients are seen for the first time in the screen room, and special efforts are often required to put them at ease.

Accordingly, the attending trained nurses who conduct patients to the screen room are instructed to avoid haste, impatience, loud tones, and unnecessary conversation, and to respond briefly but pleasantly to queries that require an answer. The assisting physician who receives the patient at the door of the screen room is cautioned not to grasp the latter by the arm and herd him into place but to keep hands off and quietly direct him

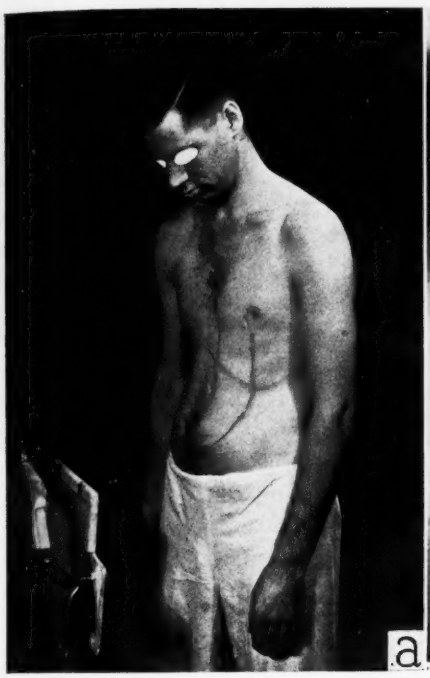

Fig. 4. Same patient as in Figures 3-*A* and 3-*B*. Fig. 4-*A*. Patient is completely relaxed and ready for examination; his head is bowed slightly, his shoulders are drooped, and his abdominal wall is loose and soft.

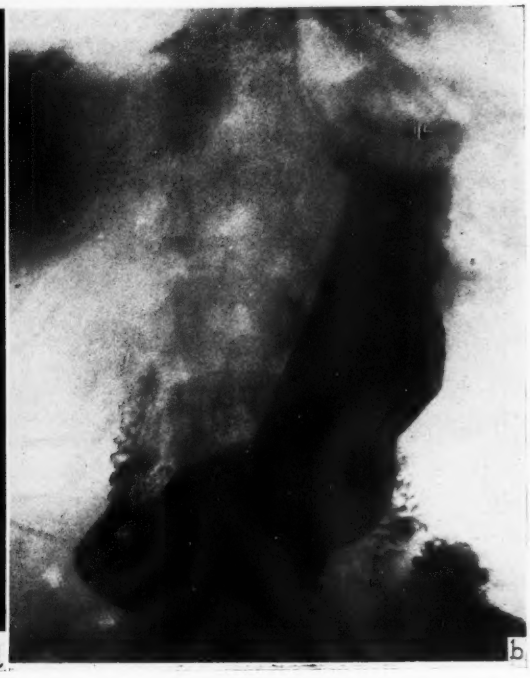

Fig. 4-*B*. Roentgenogram of the stomach with the patient posed as in Figure 4-*A;* the relaxation of the abdominal wall has permitted the stomach to descend into a position where it is accessible for manipulation (compare with Figure 3-*B*).

where to stand. If, notwithstanding these precautions, the patient obviously is under strain, the examiner engages him in conversation designed to distract his thoughts from himself. His address is stated on his reference card, and an inquiry as to conditions in his neighborhood, city, or state, or his possible acquaintance with persons known to the examiner, often restores the patient's serenity. In suitable instances a harmless jest is thoroughly efficacious, for the patient who laughs is always easy to examine.

But these measures sometimes fail. In that event the examination is suspended and the patient is sent either to an adjoining room for roentgenography, the chief purpose of which is to keep him occupied, or to another room where he can rest on a couch, during which time he lies either on his right side or abdomen, until the examination can be resumed with better prospects. Not rarely the examiner himself is at fault by reason of his own petulance which arouses a like response in the patient. Whenever I find that I am growing irritable, which is likely to occur when two or three consecutive patients are persistently and annoyingly tense, I delegate subsequent examinations to the assistants until I have regained composure. Incidentally, it is worse than useless to tell a patient that he is not co-operating as he should, for whether he resents the reproof or makes more strenuous efforts to comply with directions, the result is the same, and he becomes even more recalcitrant than before. In short, the roentgenologist should have as much friendly patience as the pediatrician, for adults undergoing medical inspection often behave like children. It may seem that I am stressing the factor of relaxation unduly, but it is one of

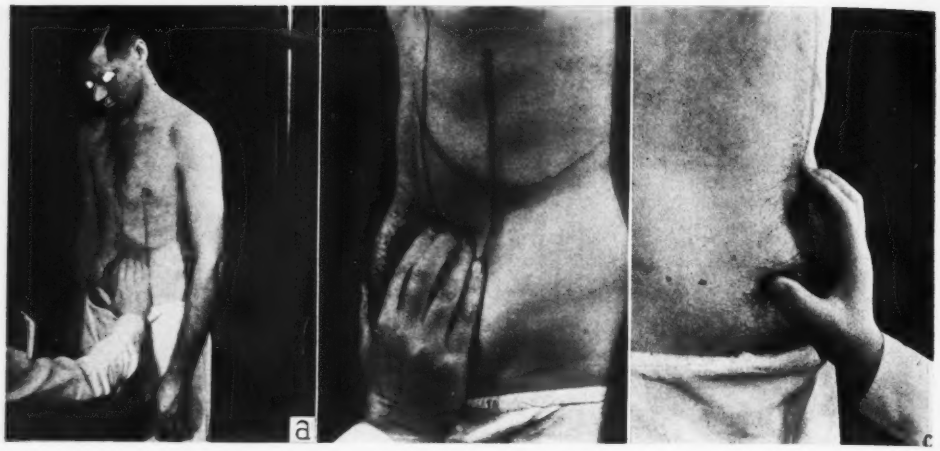

Fig. 5. Position of the examiner's hand for manipulation to fill the duodenal bulb. Fig. 5-*A*. View slightly from examiner's right.

Fig. 5-*B*. View closer up and further to right; slight pressure is being exerted with the fingers.

Fig. 5-*C*. Close-up view from examiner's left showing the cupping of his hand.

the most important elements of an efficient technic and is too often neglected.

RITUAL OF THE SCREEN ROOM

When all is ready, the patient, who has stripped himself to the hips and put on a cape of washable material, is conducted to the screen room. He is directed to stand with his back against the shield of the vertical screen apparatus; the fluoroscopic screen is swung into place before him, and the dim, green-tinted room lights are extinguished by a tap of the examiner's foot. First the examiner makes a rapid survey of the thorax and upper portion of the abdomen, then adjusts the screen-diaphragm so that the roentgenoscopic field is centered over, and comprises only, the cardiac portion of the stomach and the lower third of the esophagus. Then the room lights are turned on, and a mug containing an aqueous suspension of barium sulphate is handed to the patient. The suspension consists of 135 gm. of barium sulphate in sufficient water to make 300 c.c., and is prepared in quantity by stirring with an electric mixer. The mugs are passed into the screen room by means of revolving cabinets which exclude light from the room. Flavoring materials are not added, for the plain mixture is more palatable to most persons. Again the room lights are extinguished, and the patient is directed to take two swallows of the suspension. Entrance of the barium into the stomach at the esophageal opening, and its course toward the pylorus are observed, and by a stroking movement of the palmar surface of the examiner's approximated fingers along the axis of the stomach, from the left costal arch to the pylorus, the rugæ of the stomach are spread apart so that they can be scrutinized. Then the patient is told to resume drinking the contents of the mug. As the patient drinks, the examiner continues to apply moving or stationary, but gentle and not too frequent, pressure over accessible portions of the stomach in order to make further inspection of the gastric mucosa as it is revealed through the thinned out opaque contents, to determine the pliability and mobility of the walls, and to drive the suspension upward into the cardia so that its internal contour will be made visible by the coating of barium which remains when pressure is relaxed and the suspension gravitates downward. If small lesions are present in the accessible portion of the stomach, they become visible in the transradiant area above the examiner's pressing fingers, and can be

studied as long as he desires. In carrying out any manipulation, however, the screen-diaphragm is adjusted so that the field of illumination is not larger than necessary; the least possible amount of the examiner's hand is exposed in this field, and care is taken to avoid unnecessarily prolonged exposures. Intermitting the current during inspection, as practised at one time, has been discarded, for the aggregate of exposure time, whether intermittent or continuous, must be sufficient for the purpose, and nothing is gained by interruptions.

If the procedure thus far has failed to exhibit the cardia satisfactorily, the following manipulation is employed. The patient is told to "push out" his "stomach" against the examiner's hand, and although the phrase is not precise, the patient understands better what is meant and makes proper response by lowering his diaphragm, pouching his abdomen, and causing his stomach to descend. At the moment of greatest descent the examiner applies sufficient pressure immediately below the left costal arch to approximate the walls of the stomach, and the patient is then told to relax his efforts slowly. During this relaxing period, while the stomach is ascending to its normal position, a constant pressure is applied. By this procedure the greater part of the cardia is brought down into the field of manipulation and the mucosal relief can be inspected more thoroughly (Figs. 1-*A*, 1-*B*, 2-*A*, and 2-*B*).

Exhibition of the duodenum is watched for from the moment that the patient begins to drink the barium suspension. Often the first swallows of the mixture pass through the pylorus without pause, and fill the bulb, or it may fill later at any stage of gastric filling. If the bulb has failed to fill after all the barium has been taken, the following maneuver is carried out: After relieving the patient of the mug, he is instructed to rest his back against the screen apparatus, drop his arms to his sides, relax his shoulders, bow his head as if looking at the floor, and breathe naturally. These specific and somewhat lengthy instructions are necessary because few patients know how to relax the abdomen. When the directions have been complied with, the abdominal muscles relax, and the stomach descends to its normal position where, in most cases, it can be manipulated with facility (Figs. 3-*A*, 3-*B*, 4-*A*, and 4-*B*). The examiner now makes ready to apply manual pressure over the middle third of the stomach, at a point approximately three or four centimeters above the angle. His cupped right hand is placed obliquely across the stomach so that pressure can be exerted by the palmar and ulnar sides of the finger tips and the ulnar side of the hand. His fingers are approximated and only slightly flexed, his index finger is applied just mesial to the lesser curvature, his little finger and ulnar side of the hand at the greater curvature, and his thumb parallel to and below the greater curvature of the antrum (Figs. 5-*A*, 5-*B*, and 5-*C*). With the hand in this position, pressure can be applied in a way that will prevent escape of the gastric contents upward along the lesser curvature during the manipulation (Fig. 6). At the

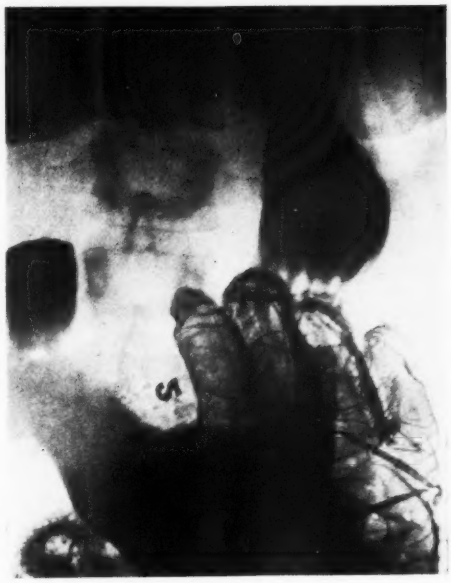

Fig. 6. Roentgenoscopy; results of the manipulation illustrated in Figures 5-*A* to 5-*C*.

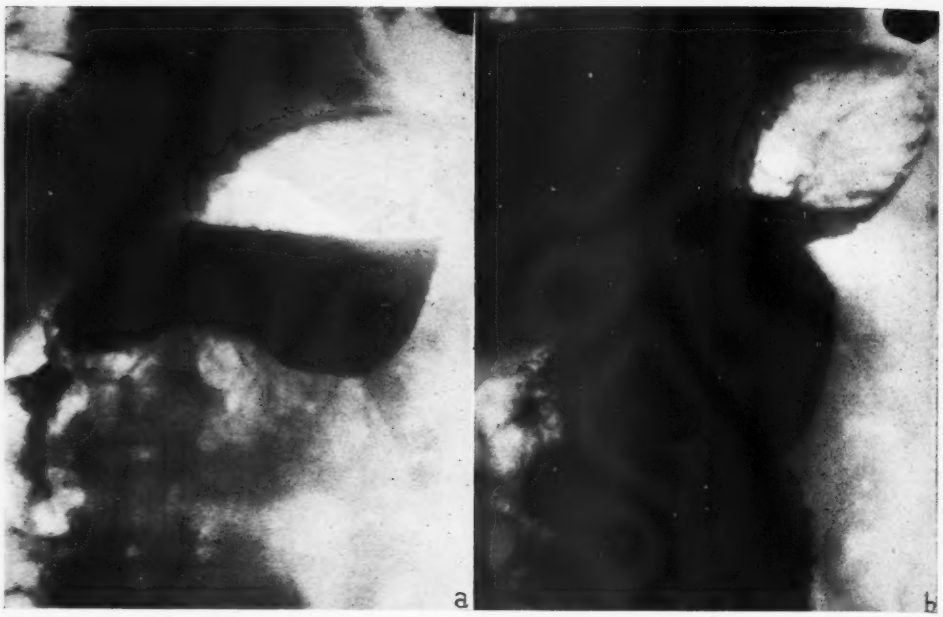

Fig. 7-*A*. Apparent cascade stomach of an apprehensive patient.

Fig. 7-*B*. Roentgenogram made after the patient had become composed and relaxed; the stomach had assumed a normal position and configuration.

moment when the disappearance of a peristaltic wave at the pylorus is succeeded by full antral dilation, the examiner exerts finger pressure sufficient to produce more or less visible division of the barium suspension, pulls his hand downward, and at the same time rotates it slightly clockwise, but without permitting his fingers to slip from their position on the skin. If necessary, as an assisting manipulation, simultaneous upward pressure against the antrum can also be made with the thumb. The effect of the entire maneuver is to drive the suspension toward the pylorus, and the latter usually opens after one or two of the manipulations. It is highly necessary that the entire manipulation be executed at the precise moment when the antrum has relaxed and a peristaltic wave is in progress toward or over it, for it is futile to apply pressure when the prepyloric portion of the antrum is contracted.

An excess of secretion in the antrum, as shown by a fluid level of the barium mixture proximal to the pylorus, is an obstacle to exhibition of the duodenum, but the secretion can either be driven through the pylorus or intimately mixed with the suspension by massaging the antrum, employing deep antiperistaltic stroking. This should begin at the pylorus and stop at the angle, and the pressure should be sufficient to approximate the walls of the region. The procedure tends to stimulate the muscular tone of the antrum and thus is applicable to hypotonic stomachs, even when secretion is not excessive. Often, also, the secretion can be forced into the bulb by lightly but repeatedly shaking (jiggling) the antral region with the palmar surface of the examiner's fingers. My predecessor, Moore, successfully employed this form of succussion, instead of the rotatory pressure that I have described, to fill the duodenum.

When the stomach is hypotonic and pendulous, as in women of enteroptotic habitus, it is more difficult to fill the duodenum by manipulation, for the antrum is elongated, and the stomach is likely to slip away from manual pressure. Bulbar filling is sometimes hindered or prevented by

an unduly rapid flow of barium through it; in this event, obstruction of the descending portion of the duodenum by steady pressure with the left hand will usually dam up the barium sufficiently to unfold the bulb.

When, by the methods described, the bulb is adequately distended so that its actual contour is depicted, the examiner expels most of its contents by sweeping pressure with his left thumb in order to bring the bulbar internal relief into view and thus disclose niches or other abnormalities that may not have been visible when the bulb was filled with the suspension.

In persons of sthenic habitus the bulb usually courses directly backward from the pylorus, and, in the postero-anterior view, is overshadowed by the antrum. In such cases it is necessary to rotate the patient into the right oblique or true lateral position to see the bulbar shadow. Occasionally this procedure is not entirely satisfactory and the patient, after placing his right hand on his left shoulder, is turned about so that the right side of his abdomen is against the shield and the screen is over his left side and back. In this oblique position the bulbar shadow is magnified because of the increased distance from bulb to screen.

TROCHOSCOPIC EXAMINATION

The screen room is also equipped with a roentgenoscopic table for examination of patients in recumbent positions. Such postures, including the supine, prone, and Trendelenburg, frequently are desirable for close study of the gastroduodenal tract, especially of the cardia. However, diaphragmatic hernias, even though small, and most other lesions of the cardia, usually can be discovered, or their presence at least suspected, at examination with the vertical screen. The table is advantageous also when, as in sthenic patients, the duodenum empties so rapidly that a good view cannot be obtained. In such cases the patient lies in an oblique position with the right side of his abdomen on the table and the screen is placed over his left side and back.

COMBATING GASTROSPASM

In many instances deformity of the stomach is attributed to gastrospasm reflected from lesions of organs other than the stomach, when in fact the distortion is the result of rigidity and retraction of the abdominal wall (Fig. 3-*B*), or of abnormally heightened gastric tonus caused by nervous tension on the part of the patient. For example, the so-called "cascade stomach" is often an effect of abdominal retraction and the stomach will return to its normal shape if the patient can be induced to relax his abdominal wall (Figs. 7-*A* and 7-*B*). Other spastic phenomena likewise often disappear when the patient's equanimity is restored. But in some cases of this character, as well as those in which the gastrospasm really arises from an extrinsic lesion, the examiner's efforts are futile. Even in such instances the spasm may have vanished spontaneously when the patient is re-examined on the following day, but it is my custom to precede this examination by administering tincture of belladonna. Three doses, of 20 minims (1.2 c.c.) each, are given one hour apart during the morning, and the patient is re-examined in the afternoon.

COMMENT

The foregoing technic is based on the general principle that every item of procedure, especially that of manipulation, should be in consonance and synchronism with the physiologic activities of the gastroduodenal musculature. With this technic, minute polyps, ulcers, and ulcerating carcinomas that otherwise might easily elude discovery can be discerned almost invariably. It can be interrupted at any time to make "spot roentgenograms" of lesions or anomalies disclosed. The growing popularity of "spot roentgenography" is gratifying, but without a well executed roentgenoscopic examination to determine sites of disease the roentgenograms will be of little avail. To be of the

highest efficiency the roentgenoscopic procedure should be orderly, fixed as to most of its details, not attended with discomfort to the patient, safe both for patient and examiner, capable of rapid execution, and applied so habitually that the successive steps are performed automatically. If the technic is so variable or disorderly that the examiner must give it constant attention, he is not free to consider his observations in terms of physiology and pathology.

SOME ESSENTIAL CONSIDERATIONS OF THE TECHNIC OF GASTRO-INTESTINAL RADIOGRAPHY

By JOHN R. CARTY, M.D., *and* VINITA MERRILL, R.N., *New York City*

WHILE at first glance, perhaps, it might be considered that the technic of radiography of the gastro-intestinal tract is relatively simple as compared with other parts of the body, nevertheless, exacting demands for more accurate diagnoses of gastro-intestinal disease have indirectly been responsible for more adequate. It is the purpose of this paper to briefly review the principles of gastro-intestinal radiography, and to discuss the radiographic technic up to the present time; also, to briefly describe a simple inexpensive device for spot-film radiography.

The essential general principles which apply to radiography of other portions of

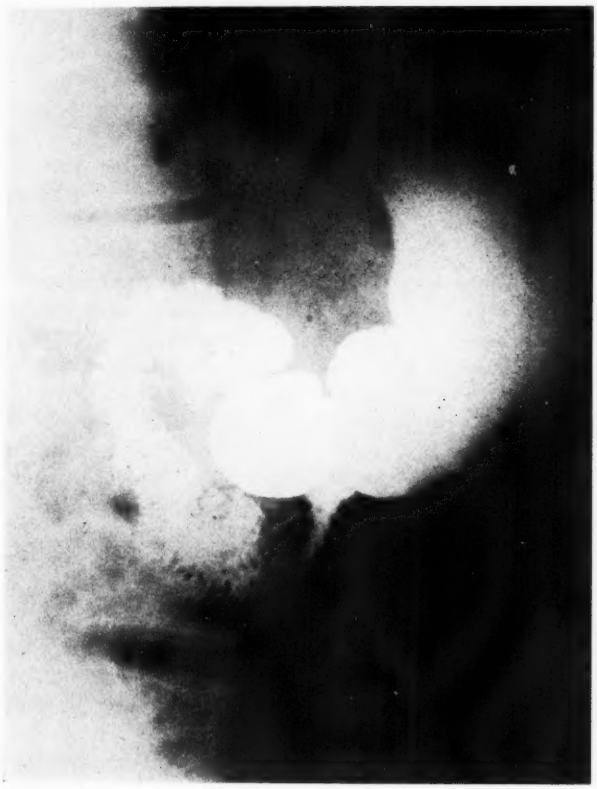

Fig. 1. Lateral film of the stomach, made with condenser discharger without a Potter-Bucky diaphragm. Note the sharp, clear-cut outline and absence of fog.

perfect radiographs, until now the technic has become somewhat complicated. Radiographs which five years ago were thought to be satisfactory are now often considered in-

the body apply in full force to gastric radiography. A perfect gastric radiograph should be absolutely sharp in outline, and have good contrast with a fine gradation scale. We have coined the word "diatrast" for this physical quality. It has been held by some that, in addition to the

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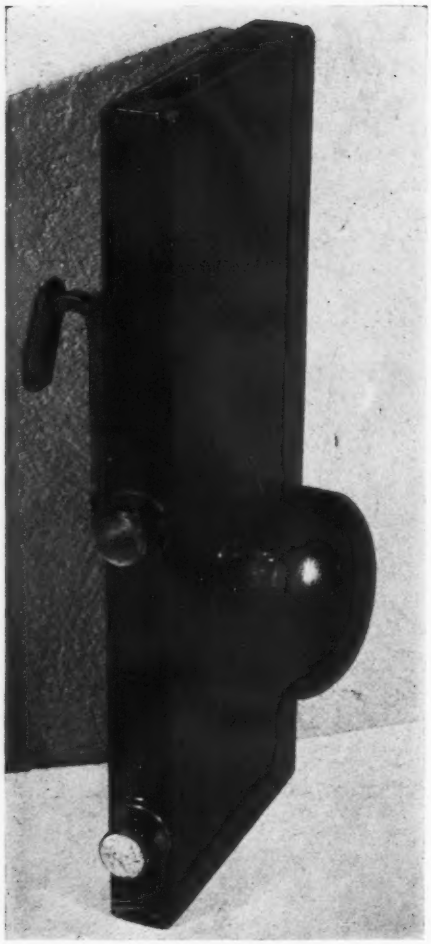


Fig. 2. Spot-film device. The hook on the back, which supports the device from the fluoroscopic machine, is shown. The compression cone and the metal stops are also shown.

sharpness of outline, the maximum contrast between the black and white is most essential. However, since the recent interest in rugal studies, a film having a good gradation scale yet maintaining contrast is perferable to visualize the finer variations of density which might otherwise be lost. In addition, such a film permits a study of the soft parts as well, which is often helpful in clearing up a doubtful diagnosis.

The most important consideration is that of stopping motion. Maintaining contrast and diatrast becomes a secondary, although important, consideration. The amount of contrast and diatrast which can be obtained will be definitely proportioned to the amount of power employed. Thus, if we are using 100 milliamperes, we would have to increase the voltage considerably over that necessary if we were using, let us say, 500 milliamperes. This, in turn would reduce contrast, particularly in the oblique and lateral views, in which case the greatly increased secondary radiation from the higher voltage would tend to cause marked fogging and blurring. If we employ energies in the range of 500 milliamperes or more, we can decrease the voltage to such an extent that this fogging is remarkably reduced without the necessity of using a small cone. This is the chief reason why a Potter-Bucky diaphragm technic is often used with the lower milliamperages. There is no doubt but that the radiograph so obtained is much improved insofar as lack of fog and increased contrast are concerned. The added time necessary tends to increase the liability to motion. In addition, there is a considerable increase in the load on the tube, with consequent decreased tube life. There is also a small amount of distortion due to an increased part-film distance, which may be undesirable in studying the small intestine.

The speed necessary to stop peristaltic motion, of course, varies greatly according to the individual, depending somewhat on the type of individual and the presence or absence of pathology. One-tenth of a second is sufficient to overcome peristaltic speed. One-fifth of a second will probably take care of a majority of cases. Speeds slower than this rapidly increase the number of radiographs showing motion. These statements apply particularly to radiographs of the stomach, small intestine, and esophagus in the upright position.

A series of gastric radiographs were made, using 30, 100, 500, and 1,000 milliamperes, keeping the kv.p. as low as possible and the time as short as the energy used would permit. Films were also made using a Potter-Bucky diaphragm technic. Radiographs were also made with con-

denser discharge outfits of two different wave forms.

There was considerable improvement between the 30 and 100 milliampere technics. The results of the 100 and 500 milliampere technics were not quite so striking insofar as contrast is concerned, although with 500 milliamperes there was no peristaltic motion. The radiographs made with 1,000 milliamperes at one-thirtieth of a second were distinctly lacking in contrast and diatrast, because of the higher voltage necessary to penetration owing to the decreasing of the time. The added speed which really was not necessary was obtained at a sacrifice of contrast and diatrast.

It is our opinion that the condenser radiographs were superior to the optimum ones, made with the impulse current (500 milliamperes, one-tenth of a second, kilovoltage range, 60 to 75).

Many radiologists are limited to the use of 100 milliamperes. We have found the following technic to give good results: 100 milliamperes, 30-inch target-film distance, one-half second time, and kilovoltage sufficient to penetrate. If, on fluoroscopy, the stomach is found to have lively peristalsis, by decreasing the distance five inches and increasing the kilovoltage by four, one can reduce the time to one-fourth second. Of course, even with this technic there will be a certain number of radiographs showing motion.

The importance of spot radiography in mucosal studies is now well appreciated. However, in practically all of this work the radiographs are apt to be of poor quality, there being considerable distortion. This is due chiefly to the short-target-film distance in most fluoroscopes. The target-table distance in the average fluoroscope is from 15 to 18 inches. If it were lengthened to approximately 25 inches, there would be considerable improvement in detail without undue addition to the technical difficulties of design. This would mean an increase of eight kilovolts, but owing to the small area of the part radiographed the secondary radiation would not be so noticeable. It is important to use as small a focal spot as possible.

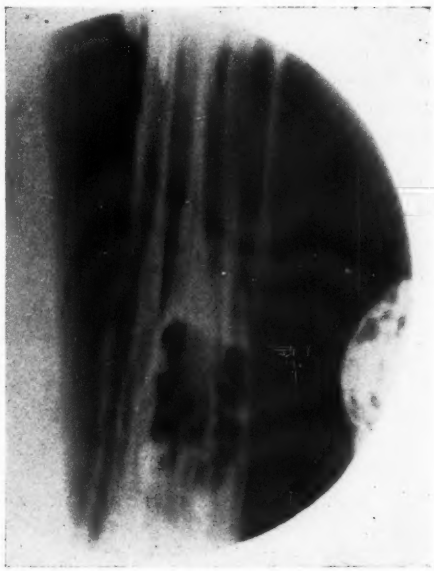


Fig. 3. Rugal study of the stomach made with a spot-film device. This is a benign adenoma.

There are several spot-film devices now available, which are apt to be complicated and are usually expensive. They incorporate a pressure and locking device, with a tunnel for small cassettes. Unfortunately, they do not use a full size 14 × 17 fluoroscopic screen.

With the assistance of Dr. E. M. Claiborne, a very simple spot-film device was built. It consists essentially of a wooden tunnel to accommodate a 5 × 7 cassette. The front and back are leaded, and there is a conical projection of wood which is pressed against the patient's abdomen. There is a circular opening in the lead opposite the pressure device. The outfit is suspended from the top of the fluoroscopic screen by two wide hooks.

The cassette is placed in the upper opening of the tunnel, and slides down as far as the upper limits of the open area, where a brass stop is located. When one is ready to make the exposure, the stop is pulled out and the cassette drops into position. When the exposure has been made, the lower stop is pulled out and the exposed

cassette appears at the bottom of the tunnel. The pressure applied to the abdomen is regulated by pushing against the fluoroscopic machine, and is most effective when some locking mechanism is provided, as on some of the newer fluoroscopes.

The tunnel grooves are so placed that the cassette is brought as near as possible to the front face of the device. This is particularly important in cases in which the focal-film distance is quite short. A lead arrow indicates the upper margin, which is useful in identifying anatomic landmarks. The device is simple and inexpensive to build and works well.

CONCLUSIONS

(*A*) The ideal gastric radiograph is described.

(*B*) Various gastric technics are briefly discussed and a satisfactory one given, using 100 milliamperes.

(*C*) Without the use of a Potter-Bucky diaphragm, 500 milliamperes at one-tenth of a second give the best results with impulse currents.

(*D*) Gastric radiographs made with the condenser discharge are superior.

(*E*) A simple spot-film device is described.

DISCUSSION

DR. FRED JENNER HODGES (University of Michigan, Ann Arbor): I personally have enjoyed these papers immensely.

One's first impression upon observing the fluoroscopic gastro-intestinal examination of large groups of patients at the Mayo Clinic is one of surprise and mistrust because of the fast tempo of the procedure. It becomes apparent upon longer observation that Dr. Kirklin and his colleagues have developed speed without sacrifice of diagnostic accuracy by employing a well-thought-out, rational procedure, beautifully synchronized and artistically applied. This procedure has been developed over a period of years and has been thoroughly tested. The published paper should serve well as a text to be followed by earnest students in this field of roentgen diagnosis. One should see Dr. Kirklin at work in his dark room in order to appreciate the importance, the vital necessity, in fact, of the various procedures he has described to us this morning. I should like very much to pay him the compliment of being the outstanding artist in that field in this country to-day.

While I, for one, place far more reliance upon fluoroscopic as contrasted with radiographic procedures in examination of the gastro-intestinal tract, I believe that both types of evidence are desirable and that radiographs must be of the very highest quality to be acceptable. Dr. Carty is known to all of us as a man who continually insists upon radiographic methods of high precision and great excellence. I very much enjoyed his presentation, particularly the slide with the beautiful mucosal relief showing a small polypoid lesion high in the stomach. Lesions such as this can only be shown by the employment of exacting radiographic technic.

DR. LESTER LEVYN (Buffalo, N. Y.): The subject of roentgenoscopic study of the stomach and duodenum has been presented from so many angles by Dr. Kirklin that one can add but little to his thorough discussion.

The first thought that occurred to me, however, is the absolute necessity for fluoroscopic examination. I stress this because I know several roentgenologists who do not use the fluoroscope except on rare occasions or only when they are requested to do so by the clinician or the surgeon. I hope that some of these men are in attendance. If so, they will realize after hearing Dr. Kirklin that an examination is at most but 50 per cent efficient without a careful roentgenoscopic observation.

The necessity of remaining in the screening room sufficiently long for the retina to become accommodated was emphasized. Screening is of little avail unless this is strictly adhered to. At times I have looked at films in view-boxes with men who asked to be excused for a few moments to fluoroscope a patient and who returned from the screening room to the view-boxes

before retinal accommodation in the dark could possibly occur.

Regarding the six-hour motility test as mentioned by Dr. Kirklin, I personally believe that a residue at the end of four hours is as significant as at the end of six, especially if the barium is given in a carbohydrate medium. Normally complete evacuation of the stomach from such a meal occurs in from two to two and a half hours.

The most important message that Dr. Kirklin brought to us, in my opinion, is that fluoroscopic manipulation should synchronize with certain physiologic phases. Certainly his painstaking technic discloses lesions that frequently might be overlooked were he to rely more on the use of films and less on the use of the screen.

Both Dr. Carty and Dr. Kirklin mentioned spot roentgenograms briefly. When a lesion is detected under the fluoroscope, the roentgenogram must be made immediately. This is of paramount importance. One may not detect the lesion on the films if the patient is moved to another room and the roentgenograms made there.

When patients are nervous and tense, the administration of phenobarbital for a day preceding the examination is of value—at times even more so than belladonna unless spasm is reflex from some extrinsic source, and in some cases a combination of both is effective.

Dr. Carty's conclusions following his series of roentgenograms of the stomach in which he employed milliamperage ranging between thirty and one thousand are most interesting. I have seen some of his films made without the Potter-Bucky diaphragm and they were technically brilliant.

At the hospital we have found that 200 milliamperes at a tenth of a second have given us most satisfactory films—elimination of motion with sufficient yet not too great contrast.

Dr. Carty has found that roentgenograms made with the condenser type of machine are superior to the best made with the impulse current. The condenser type, however, is too inflexible. It has a distinct field in instances in which the power line is small or in which there is a direct current only, but otherwise has many limitations as compared with the use of the impulse current.

The simple spot film device designed by the essayist certainly appears to be most efficient, as he has demonstrated it, and judging from some of the slides he has shown. I have seen one of these in Buffalo, made by one of the men who worked recently with Dr. Carty, and his films compare favorably with those made with very expensive equipment now on the market.

DR. LEWIS GREGORY COLE (New York): I did not get here in time to hear Dr. Kirklin's entire paper but I can guess pretty well what he said. I did, however, get here in time to find out from Dr. Carty that I was one of those inefficient roentgenologists, against whom he warned you, namely, one who primarily uses radiography instead of radioscopy for gastrointestinal diagnoses.

Whether I am inefficient or not, I do prefer to have a definite roentgenologic record which may be kept, so that one film may be matched over another and so that one may sit down and really study the roentgenologic findings instead of depending on a transitory visual examination.

I have no objections whatever to Dr. Kirklin or Dr. Carty or anyone else depending upon the fluoroscopic examination and using as few films as he desires, or indeed not using any films, but what I do object to is roentgenologists trying to persuade other less experienced people to depend upon fluoroscopic examinations rather than on the permanent record obtained by roentgenography. When Dr. Carty has had as much experience as the older men who were instrumental in the development of gastro-intestinal diagnoses and who at least depended on roentgenograms to prove that the things they saw or thought they saw fluoroscopically were really there, he will then be in a position, if he so desires, to criticize those who wish to do things differently from what he does.

Dr. Arthur R. Bloom (Detroit, Mich.): I am sorry that I missed most of the early part of the papers but I have gathered sufficient information from the discussion as to the advantages of the use of fluoroscopy *versus* plates in gastro-intestinal work. I find in my work that I get better results from a combination of both.

I was interested in a lot of expensive equipment that was shown at the commercial exhibit. I have made some very inexpensive equipment of my own which I will just take a second, if I may, to describe with the help of the blackboard.

On the question of taking spot films, the device I use cost me exactly $5.00 and it consists of a board $6^1/_8 \times 15^7/_8$ so that a 5×7 film fits in here.

I localize the lesion that I want. I have a little push rod in here and I can expose half of the 5×7 film and then get another site and push the film over and expose the other side.

The side view of this apparatus is simply this: A wood projection with a hole in it $3^1/_2$ inches in diameter. This, of course, has a couple of hooks which hang on to the fluoroscopic screen and the whole thing cost me $5.00.

In addition, I also use a regular serial tunnel which, instead of $80, cost me about $12.50. Inside of the tray I have fitted a board with an opening just enough to fit an 8×10 cassette and four lead points for centering each quarter. I can localize the cap so that I get four views on an 8×10.

In addition to that, I have designed another device for compression, which cost $1.55. I get a Mensingo pessary (costs, $1.50) and put it on a piece of cardboard. Inside I have a five-cent toy balloon which is inflated. With a patient lying prone on the table, I place the pessary underneath him and thus get compression of the cap.

Dr. Merrill C. Sosman (Boston, Mass.): I would like to say just a word about a device that doesn't cost anything but which is of definite benefit in securing a satisfactory examination of the duodenal cap.

A great many patients will be either frightened or tense, or not relaxed, and you will not be able to get an outline of the duodenal cap even with all the manipulations that Dr. Kirklin so nicely described.

It has been my experience, on the basis of Dr. Cannon's physiological studies, that we can secure this by suggestion—and that is simply the method of mentioning of food which appeals to the patient. If you have a big, husky man and his pylorus is shut down tight, you start by talking to him about beefsteak or ham and eggs, and if it is around Thanksgiving time you may describe a mince pie, a good, thick mince pie with a beautiful flaky crust on it, rich, juicy, warm. Put a big gob of ice cream on top of that pie and you can see the barium rush through the pylorus!

We have used this stunt for years in our department. It is not a joke. It is a perfectly serious proposition and I am passing it on to you and you may try it. It is of great value in shortening the time of examination.

If you have a woman, as a rule she won't respond to beefsteak or ham and eggs or mince pie, but she will respond to salad. Salads just simply force barium through the female pylorus! Particularly a nice lobster salad roll or chicken salad. They are great!

But be careful if you have a Jewish patient not to mention lobster salad because they can't eat lobster.

To the third paper on the program I would like to add my own experience. That is, disregarding all of the disagreement on the malignancy of the ulcer from the pathologic viewpoint, the end-result (and that is the important thing, after all) five to ten years after you have seen your patient will show that there is a fifty-fifty chance that a lesion in the prepyloric zone will be carcinoma, and I would certainly agree with Dr. Holmes that I would not take a fifty-fifty chance of a carcinoma in my stomach. I would have it taken out.

DR. B. R. KIRKLIN (closing): Dr. Hodges mentioned the question of speed in making fluoroscopic examinations. Although speed is not an all-important factor, I do feel that if one has a routine technic patients can be examined rather quickly. I heard Carman once say, "The longer one looks, the more one is apt to see that does not exist." The examination should be regarded as completed at the moment when the examiner forms a definite idea as to the significance of the manifestations presented.

There has been some discussion this morning as to the relative merits of the fluoroscopic and radiographic methods for making gastric and duodenal diagnoses. I do not care to enter into this discussion except to say that I am convinced that Dr. Lewis Gregory Cole is an artist with the film method alone. Personally, I prefer using both methods although I depend primarily on the fluoroscopic examination, with films to record the findings.

I have enjoyed hearing the other papers on this symposium, and there is one point which I think should be emphasized in Dr. Carty's paper, namely, that a throw-over switch, which enables one to switch immediately from fluoroscopic current to radiographic current, is very essential for satisfactory spot radiography, otherwise a peristaltic wave may come along in the meantime and alter the appearance of that portion of the stomach which one wishes to radiograph.

In closing, I wish to thank those who so kindly discussed my paper.

DR. JOHN R. CARTY (closing): I wish to thank Dr. Hodges and Dr. Levyn for their very kind and interesting discussions. I fear I have been classed—shall I say unwillingly?—as a user of the radiographic method exclusively. I will not enter into a discussion as to the relative merits of the fluoroscope *versus* the radiograph, as we use both methods. We do a very careful fluoroscopic and radiographic examination on each case. In my experience, the two methods supplement each other; they both are very important.

I would like to bring up one point regarding the use of spot film devices, somewhat in the nature of a warning. When we make a rugal study, it is very often to demonstrate a penetrating lesion. Some of these may be very thin. With every spot film device we employ a lever, which is a machine capable of generating a great deal of pressure. I fear that unless we bear this in mind we are apt to have unpleasant experiences.

Dr. Sosman showed me that if we conversed with the patient during the fluoroscopic examination about food, the pylorus would relax. In this connection I once had a rather amusing experience. We usually kept to beefsteak and French fried potatoes in our conversation, but this time I included mushrooms, and the patient had reverse peristalsis and vomited. I found out afterward that the patient had been severely poisoned, the year previous, by mushrooms picked in a field.

In regard to Dr. Kirklin's remark about a switch: in our outfit we have a timer next to the screen, which, when operated automatically, gives us a higher setting for radiographic exposure. The foot switch when operated automatically, gives the proper factors for fluoroscopy.

DR. JOHN D. CAMP (Rochester, Minn.): I am sure that with all the discussion of roast beef, steak and mushrooms and certain beverages, we are in a poor mood for the reception of much more scientific information, so I will try to keep my remarks short.

The group of papers on the program this morning indicate the interest of the entire medical profession in the problems relating to the small intestine. Certainly if roentgenologists are going to accomplish anything in the solution of these problems—and I believe that we are in most excellent position to do so—we have got to standardize our technic. At least we must use a uniform radiopaque meal, the roentgenologic characteristics of which are thor-

oughly familiar to all. I think Dr. Pendergrass and his colleagues hit the nail on the head in their paper concerning this subject. I am glad that they have emphasized the water-barium combination. Our experience with it certainly seems to justify all that they have claimed for it.

The essayists of the first paper and Dr. Pound have emphasized the occurrence of changes in the small intestines in certain systemic diseases. Clinicians for many years have suspected changes in the small intestine in certain systemic diseases and particularly those involving calcium metabolism. It is quite evident from the experience of the essayists and other work described in the literature, that these changes in the small intestine play a very important part in these diseases. Whether or not they are the primary cause of the disease or a secondary change due to a deficiency factor will have to be proved. Certainly their demonstration by roentgenologic methods is a great step in the solution of this problem because postmortem studies are greatly handicapped by rapid disintegration of tissues of the intestinal tract.

In regard to tumors, I think the roentgenologists are in a pre-eminent position to establish the diagnosis of these lesions. A survey of the literature (particularly Hartmann's article two years ago summarizing a large group of cases) indicates that about half of these tumors were discovered accidentally and that in the other half where symptoms were related to the tumor, only 50 per cent, or a quarter of the entire series, had symptoms of obstruction.

It is quite obvious from the literature that the chief clinical signs for the diagnosis of small intestinal tumors have been symptoms of obstruction, so if we depend on the clinical evidence there is a possibility of missing, according to the literature, 75 per cent of these lesions.

Since the literature indicates that many of these tumors are susceptible to identification by the roentgenologist, I think that the information we have had conveyed to us this morning certainly should increase our ability in this respect and stimulate many of us to scrutinize the small intestine more carefully and thereby make the diagnosis earlier in many of these lesions.

I would like to leave one word of caution. We are treading into a field which clinically involves many conditions said to be functional, and therefore we should be careful to have a definite physiologic and pathologic basis for our conclusions. When we enter the realm of functional diagnosis, there arises considerable doubt, so unless we can standardize our methods of investigation and have definite pathologic and physiologic data upon which to base our conclusions, I think for the time being, at least, we should be very careful about any decisions we may make.

INTRAVENOUS UROGRAPHY IN CHILDREN[1]

By M. SWICK, M.D., *New York City*

THE pediatrician not infrequently is called upon to determine the cause of an obscure fever, a persistant pyuria or to diagnose the nature of an abdominal mass. There may or may not be outspoken accompanying urinary symptoms and signs, as in carbuncle of the kidney or in certain types of hydronephrosis. Furthermore, the physician has been inclined frequently to dispose of a case of pyuria with the diagnosis of pyelitis, or to perforce remain in the dark regarding the origin of an obscure fever. Under these circumstances excretion urography has been of considerable help both for diagnosis and as a survey study. This is particularly so when retro-

Fig. 1.

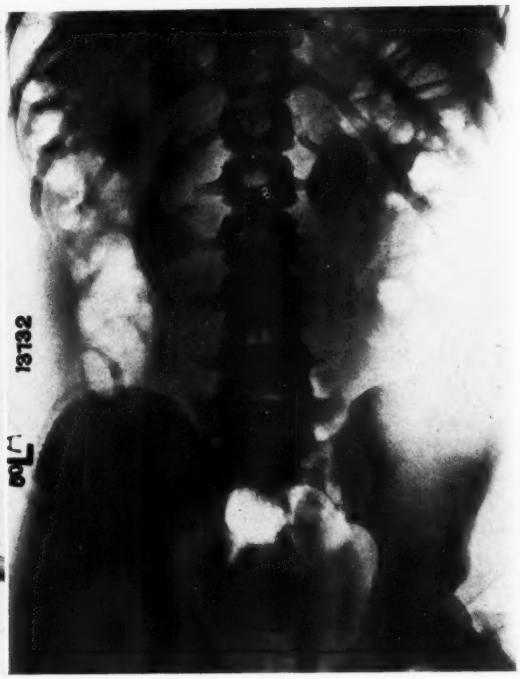


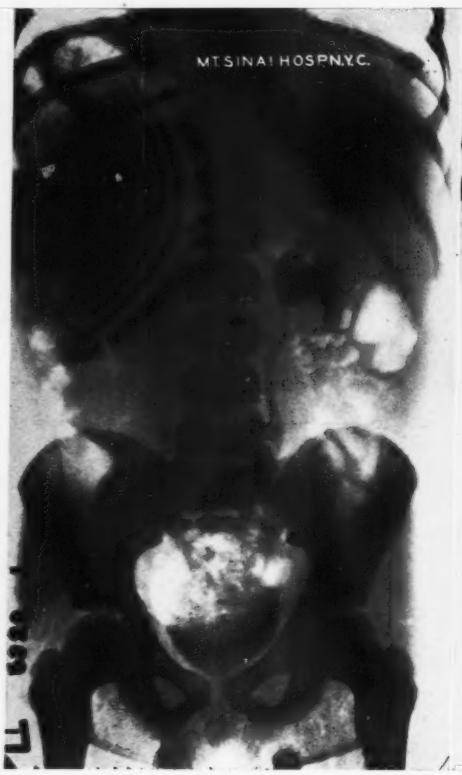
Fig. 2.

Fig. 1. Fused kidney, in a one-year-old child, admitted for abdominal pain. An ovoid mass to the left of the umbilicus was felt. Urogram shows congenital ectopia of the right kidney anlage and fusion with the left half. The pelves and calyces face each other in the fused kidney mass. The ureter of the left half is seen crossing laterally; the right across the vertebral column.

Fig. 2. Horse-shoe kidney. The calyces on the left side point mesially; the ureter arises laterally. The calyces on the right side are arranged in umbrella-like fashion. Several calcified mesenteric lymph glands are seen on the right side.

the symptoms and signs may be predominantly of a non-urinary nature. Because of inherent difficulties and inconveniences which may be associated with cystoscopy and retrograde pyelography in children, grade pyelography may be at times mechanically impossible, taxing, or dangerous. As a result, the status of the urinary tract in general, and congenital anomalies in particular, is being determined with greater accuracy and frequency in children. I do not mean to relegate retrograde pyelography to a minor rôle in children, nor do

[1] Presented before the Radiological Society of North America, at the Twenty-first Annual Meeting, in Detroit, Dec. 2–6, 1935. This paper was discussed with others (see RADIOLOGY, March, 1936, **26,** 291).



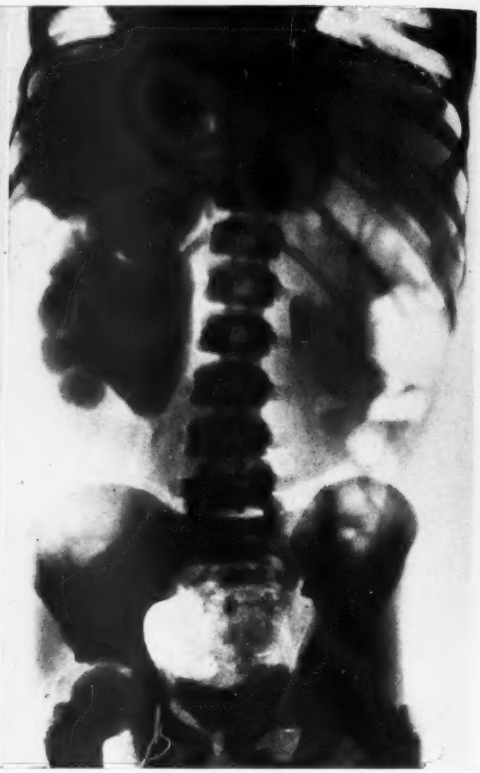


Fig. 3. Fig. 4.

Fig. 3. Left hydronephrosis in a 12-year-old boy, previously diagnosed as pyelitis, showing a right normal urinary tract and the early filling of dilated calyces in the region of the left kidney shadow. (See Fig. 4.)
Fig. 4. Same patient as shown in figure 3, demonstrating the intense and complete visualization of the left hydronephrotic kidney, obtained several hours after the injection.

I mean to infer that excretion urography is not without its limitations, nor that it can supplant cystoscopy, retrograde pyelography, or ureteral catheterization. However, as one aid in urologic diagnosis, and when viewed in conjunction with the history, physical and laboratory findings, it has helped in clarifying diagnostic problems for the pediatrician.

In order to better interpret and evaluate the anatomic results obtained by excretion urography, a consideration of some general principles will not be amiss. Excretion urography depends for its success upon the functional activity of the kidney parenchyma. More specifically, it is upon the concentrating property of the kidney cell that the success of excretion urography depends. When the concentrating power is impaired or absent, as in the poorly functioning kidney, the roentgenologic visualization will be correspondingly poor or entirely absent. On the other hand, in the presence of urinary tract obstruction, visualization is still possible although the level of excretion be diminished. Thus, in cases of hydronephrosis, despite comparatively little intact renal tissue, good visualization may still be encountered. In hydronephrosis then, the presence of functioning renal tissue, as evidenced by intense radiologic shadows, is no quantitative criterion as to the extent of functioning renal tissue, and is therefore not an accurate guide to the type of therapeutic procedure. The latter will depend upon the individual case, the pathologic-anatomic status, as well as upon the particular approach of the physi-

Fig. 5. Case of contracture of the neck of the bladder in a four-year-old child, showing dilatation of both upper urinary tracts, particularly the left one, the ureter of which is not definitely seen. The bladder outline is indicated as a large ovoid shadow, the upper border overlying the lower poles of both kidneys. (See Figure 6 for complete outline of markedly distended bladder incidental to the contracture.)

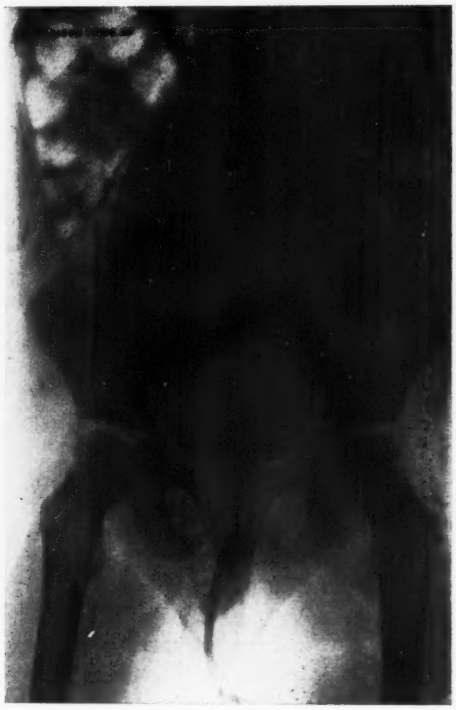


Fig. 6. Same case as shown in Figure 5, demonstrating the enormously distended urinary bladder, several hours after the intravenous administration of the urographic medium.

cian or surgeon. The following example is illustrative: A 12-year-old boy was admitted for pyuria and left loin pain. Excretion urography revealed a normal right urinary tract and the intense visualization of a huge left hydronephrotic kidney. The latter, despite the intense visualization, was found at operation to be nothing more than a huge hydronephrotic sac-kidney with small islands of intact renal tissue, and was accordingly extirpated. (Figs. 3 and 4.)

Again, it is important to realize that the functional activity of the kidney may be temporarily diminished or inhibited, although the kidney parenchmya be anatomically intact. This may result from either occluding lesions or trauma. The mechanism of total functional inhibition in the presence of intact renal tissue may be open to question and difficult of proof. Yet for practical purposes, the concept of temporary functional inhibition may be entertained in cases in which the non-visualization of the urinary tract at one examination has been followed later by the return of visualization after the removal of the causative factor. Such experiences have been observed in one case following trauma from retrograde pyelography and in another from a high occluding stone. This should, therefore, emphasize the fact that it is dangerous to conclude in every case that the kidney parenchyma has been permanently damaged beyond repair because of the non-visualization of a urinary tract at one examination.

On the other hand, permanent non-visualization of a urinary tract incidental to the functional-anatomic derangement of the kidney parenchyma may be of great assistance in localization and diagnosis

when considered together with the other clinical data. Cases of calculus pyonephrosis, tuberculosis, congenital infected hydronephrosis, and neoplasm of the kidney have been so diagnosed when viewed clinically in their entirety.

The series of illustrations shown will demonstrate the value of excretion urography, and the results obtained in children in detecting obstructive lesions of congenital origin or of lesions either obstructive or infectious superimposed upon congenitally anomalous conditions. Children with pyuria attributed to pyelitis have been not infrequently found to be suffering from infections either superimposed upon congenital lesions, such as the infected hydronephroses, or tuberculosis, calculus pyonephrosis, or urinary retention due to contracture at the neck of the bladder. We make it a routine practice to subject every child with pyuria to excretion urography, irrespective of the duration of the condition or the nature of the previous treatment. As a result, the diagnosis of pyelitis is made only after exclusion of other pathologic lesions in the upper urinary tract. In addition, repeated examinations at different intervals by this method greatly facilitate a knowledge of the progress of the underlying condition.

In the differentiation of abdominal masses, whether of intra- or extra-urinary origin, excretion urography has at times been of invaluable aid. In this manner, congenital solitary kidney, ectopic fused kidney, and dystopia of the kidney have been recognized.

In kidney reduplication, the visualization of one kidney pelvis stunted in its appearance and a failure to account for the other should make one suspicious of the presence of a double kidney and call for cysto-pyelographic investigation.

The success of visualization in polycystic kidney disease by the excretory route depends upon the degree of renal decompensation. In general, the results in this condition have not been very satisfactory from a roentgenologic point of view due to the impaired concentrating power of the kidneys.

To summarize, we employ the less taxing and simpler method of excretory urography first, both for diagnosis and as a survey study. In addition to the intravenous method I have also employed the subcutaneous route with satisfaction. In cases in which corroborative or supplementary evidence is necessary, or the results from excretion urography are equivocal, retrograde pyelography is carried out. Excretion urography is contra-indicated in uremic individuals since it yields no anatomic data and may be attended with danger.

ATYPICAL DISTRIBUTION OF PLEURAL EFFUSIONS[1]

By LEO G. RIGLER, M.D., *Minneapolis*

From the Department of Radiology, University of Minnesota and the University Hospital, Minneapolis

CERTAIN conceptions about the distribution of fluid in the pleural cavity have been maintained since the earliest studies in physical diagnosis. The development of the roentgen examination of the chest has served, in some respects, to substantiate these conclusions. There is a general idea, expressed in most textbooks, in the literature, and widely held by roentgenologists and physical diagnosticians, that liquids in the pleural cavity, in the absence of pneumothorax, take on a fairly definite, uniform appearance on roentgen examination. This appearance is described, typically, as a dense shadow which, in the early stages of an effusion, obliterates the normal aeration of the costophrenic angle; as the fluid increases, the shadow extends medially over the diaphragm and upward along the periphery of the chest. The upper surface of this density is concave, and the shadow rises higher in the lateral and posterior than in the medial or anterior portions of the thorax. When a massive effusion is present the entire hemithorax is dense so that there are no levels or surfaces and obviously no possible differences in position. The position of the fluid in the latter type of effusion requires no discussion.

In the cases in which the effusion does not completely fill the pleural cavity, the description given above will probably hold true, in the majority of instances, if the roentgen examination is made in the usual upright position. Contrary to much opinion in the literature, a change in position of the patient will, in the greater number of cases, produce a distinct change in the position of the fluid; not, however, to the same extent as would occur if gravity were the only factor involved. This has been abundantly proved by the author (3 and 4) and others in previous papers. The shifting occurs whether the fluid is exudative or transudative in nature. A change in the position of the patient from upright to supine (Fig. 1) may cause the shadow of the fluid to change from the typical appearance described above, to a thin density throughout the chest. If the patient is placed in the lateral decubitus position, a postero-anterior exposure being made, the upper surface of the fluid may appear quite flat rather than concave, and the dense shadow of the fluid will occupy largely the inferior costal gutter. The cases in which no change in position of the fluid occurs are invariably exudative in type; they are either of long standing so that adhesions have formed, or of more recent origin with pus of a thick fibrinous character.

Aside from this shifting with change in position, however, there is a group of cases in which the fluid, even in the upright position, presents an appearance which is radically different from the usual picture described above. In such patients there are so many variations in the position of the fluid, and in the appearance of its upper surface, that interpretation of the roentgenograms may be difficult and diagnostic error may result. These atypical cases group themselves into a number of categories, the most common type including those in which the upper surface of the fluid is almost perfectly flat. Variations in the degree of concavity of the upper surface of pleural effusions are a common observation, but the demonstration of a rather flat surface, as shown in Figure 1-A, on the left side, may readily lead to the diagnosis of hydropneumothorax, even though no gas is present in the pleural cavity.

In another group, the upper surface of

[1] Presented before the Radiological Society of North America, at the Twenty-first Annual Meeting in Detroit, Dec. 2–6, 1935.

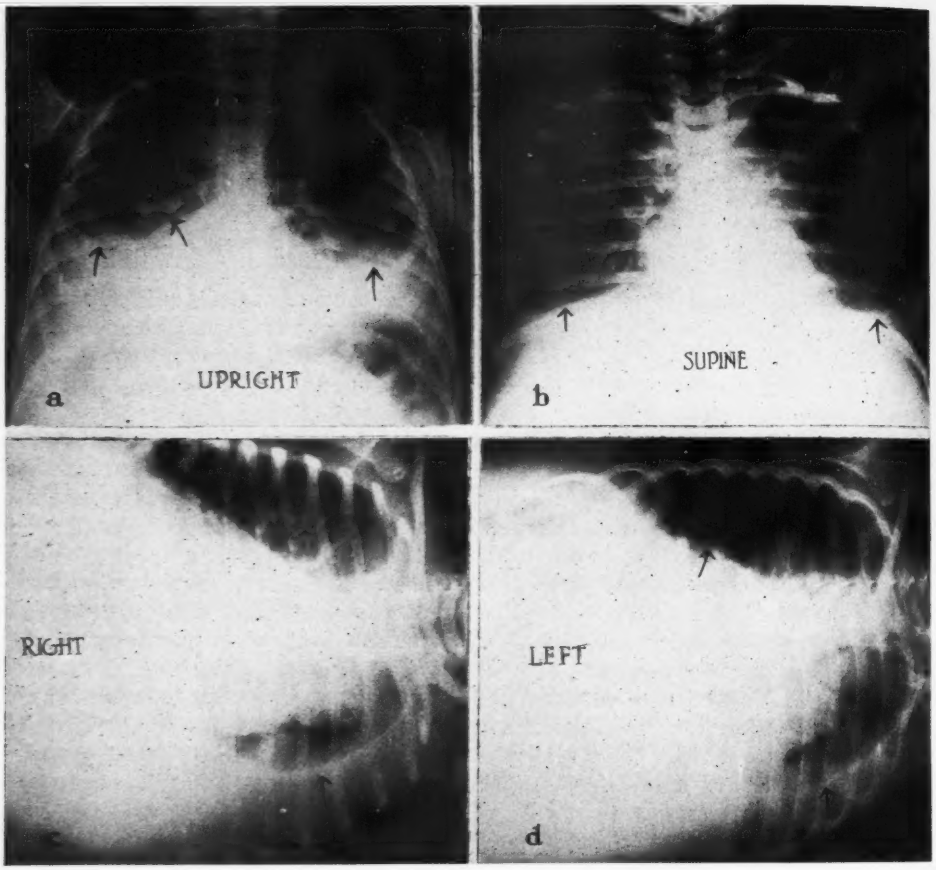


Fig. 1. Case of bilateral pleural effusion in a child, secondary to lipoid nephrosis. (*A*) Roentgenogram in upright position, showing fluid on both sides. On the right, it extends upward peripherally in a somewhat characteristic fashion, but there is a considerable amount of fluid extending into the mediastinal pleural space simulating an enlarged heart. On the left, the fluid has a rather flat upper surface.

(*B*) Supine position. The fluid extends in a thin layer throughout both lungs. Note particularly, however, the density over the diaphragms and at the periphery, especially on the right side. The accumulation of fluid over the apices and extending into the superior mediastinal pleural space on both sides is notable (upper arrows).

(*C*) Right lateral decubitus position. The fluid on the left side simulates the left heart, and undoubtedly lies largely behind it although some can be seen at the apex. On the right side the fluid is in the inferior costal gutter (lower arrow). Note the concave upper surface.

(*D*) Left lateral decubitus position, showing the fluid on the right side hidden behind the heart and simulating an enlarged right heart. On the left side, the fluid shadow is exactly similar to that on the right in Figure 4-*C*.

the fluid shadow is somewhat convex and leads to the mistaken diagnosis of elevation of the diaphragm or, possibly, of subphrenic abscess. These are less common, but the author has observed some six cases, two of which were reported in previous publications (3 and 4) in connection with other observations. Failing to note these cases, Yater and Rodis (6), in 1933, reported a case of pleural effusion simulating a high left diaphragm, and commented on its rarity. They were unable to find any previous comment in the literature anent this subject and were at a loss to explain its occurrence. In Figure 2 is represented a typical case of this type. Figure 2-*A* is the roentgenogram, made in the upright position, of the chest of a child with lipoid ne-

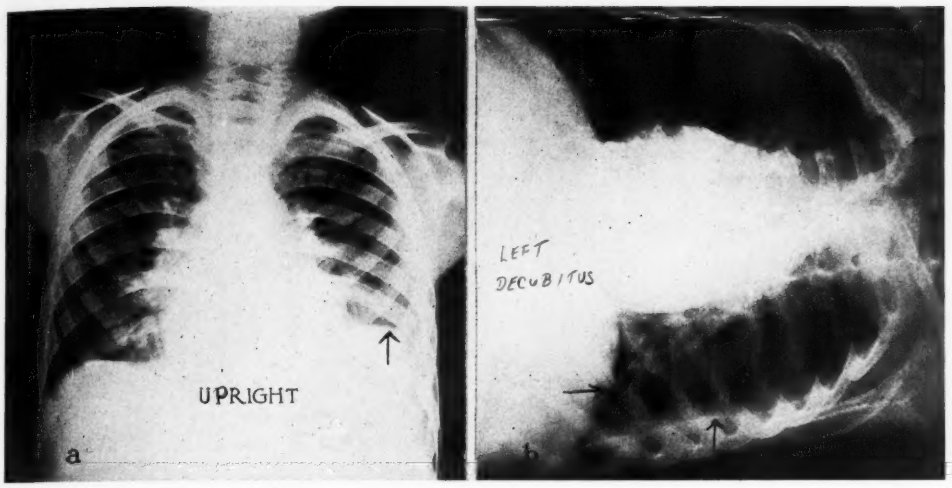


Fig. 2. Case of lipoid nephrosis in a child with left-sided pleural effusion. (*A*) Upright position, showing shadow of fluid at left base simulating an elevated left diaphragm. There is some slight density above this suggesting fluid, but this might well be interpreted as atelectasis of the lung from compression.
(*B*) Left lateral decubitus position, showing diaphragm clearly outlined (arrow) in normal position, and fluid in the inferior costal gutter showing a flat upper surface (arrow).

phrosis. The upper surface of the fluid is somewhat convex (arrow) and strongly resembles an elevated left diaphragm or the findings of a left subphrenic abscess. There is some density above its suggestive of fluid, but the most striking finding is the shadow over the diaphragm. Another case of a similar type is demonstrated in Figure 3; this patient was suffering from a general carcinomatosis. The appearance of the upright roentgenogram (Fig. 3-*A*) suggested a high, irregular, right diaphragm, such as might be produced by a liver enlarged from metastases. The inner arrow points to a shadow somewhat suggestive, but not at all diagnostic, of fluid. The rather moderate difference in the height of the two diaphragms is notable in view of the large amount of fluid actually shown, by the other examinations, to be present on the right side.

It is of interest to note that Korol and Scott (2) have recently stated that the appearance described by Yater and Rodis is due to a concealed air pocket which might have been demonstrated in the lateral decubitus position. While I have no doubt that concealed air pockets occur, it should be noted that, in the cases reported here, all possible postures, including both lateral decubitus positions, were used during the course of the examination without any air bubble becoming apparent (Fig. 1). Furthermore, these cases were transudative in nature; no paracentesis had been done before the roentgenograms were made. There is, therefore, not the slightest reason to suppose that any air was present, and I have no doubt whatever about its absence.

In a third group of cases the fluid extends chiefly into the mediastinal pleural space with only a small amount apparent at the periphery. The roentgen appearance, under such circumstances, may simulate a mediastinal tumor or a markedly enlarged right atrium. Cases illustrating this phenomenon are shown in Figures 4 and 5. Figure 4-*A* represents the roentgenogram, made in the upright position, of the chest of a man suffering from cirrhosis of the liver, ascites, and chronic mediastinitis. There is clear evidence of fluid in the left pleural cavity. On the right side there is also evidence of fluid at the

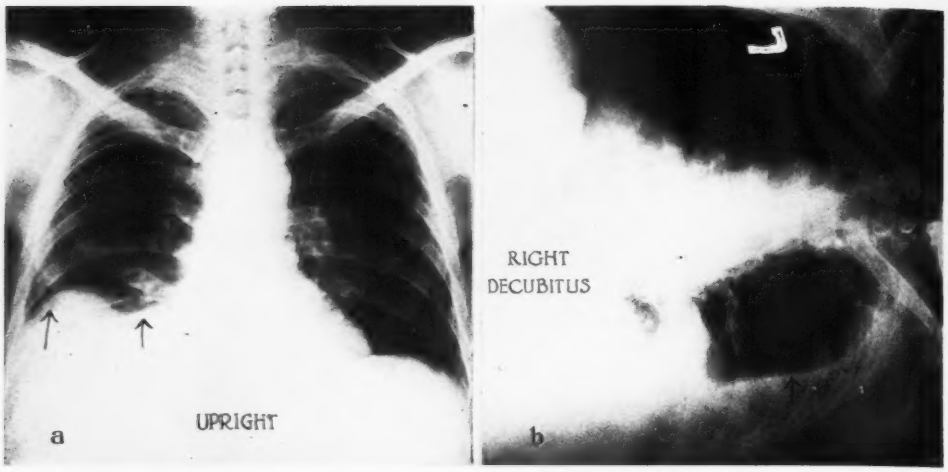


Fig. 3. Case of general carcinomatosis, with fluid in the right pleural cavity simulating a high right diaphragm. (*A*) Upright roentgenogram, showing apparent elevation of right diaphragm of an irregular character (arrow). This appearance is due to an accumulation of fluid over the diaphragm.
(*B*) Right lateral decubitus position, showing the fluid in inferior costal gutter with somewhat concave upper surface (arrow). Note also the mass of fluid extending toward the mediastinum which is, no doubt, in the inferior anterior portion of the main interlobar fissure.

periphery (lateral arrow), but, in addition, there is a large rounded mass continuous with the heart shadow (medial arrow). This resembles very closely a markedly enlarged right atrium. The second case of this type is shown in Figure 5-*A*. This roentgenogram was obtained in a patient suffering with multiple peritoneal and pleural metastases from a carcinoma of the ovary. Here again there is clear evidence of fluid on the right side, but, in addition, there is a very large dense shadow extending along the mediastinum (lower arrow), simulating a mediastinal tumor or possibly a greatly enlarged ascending aorta.

The fourth group of cases have been commented upon by the author in previous publications (3 and 4). It has been shown that fluid in the pleural cavity, in certain positions, extends into the interlobar fissures, simulating encysted effusions, although the fluid is entirely free. The author has discussed this phenomenon at length in another publication (5), so that it needs no further elaboration here. An illustration of this occurrence, however, is shown in Figure 3-*B;* with the patient in the right lateral decubitus position, the free fluid in the right pleural cavity extends in a large mass into the inferior, anterior portion of the main interlobar fissure. In Figure 4, extension of the fluid into the minor interlobar fissure is shown both in the upright and supine positions (upper arrow Fig. 4-*B*). Likewise, in Figure 5 the fluid can be seen extending into the superior, posterior portion of the main interlobar fissure in both the upright and supine positions (upper arrows).

Fortunately the differentiation of these various atypical cases of pleural effusion can almost always be made with ease by roentgenoscopic or roentgenologic examination in a variety of positions. Films made with the patient prone, supine, or in the lateral decubitus position, as described by the author (3), will invariably demonstrate a sufficient shift in the shadow to indicate that a liquid medium is present. The result of changing the patient's position is well illustrated in the cases reported here. In the first case, for example, the upright position (Fig. 1-*A*) shows the fluid on both sides near the base of the lung, although it does rise peripherally and medially, especially on the right side. In the supine position (Fig. 1-*B*), the fluid spreads out in a thin layer throughout the thorax, leaving

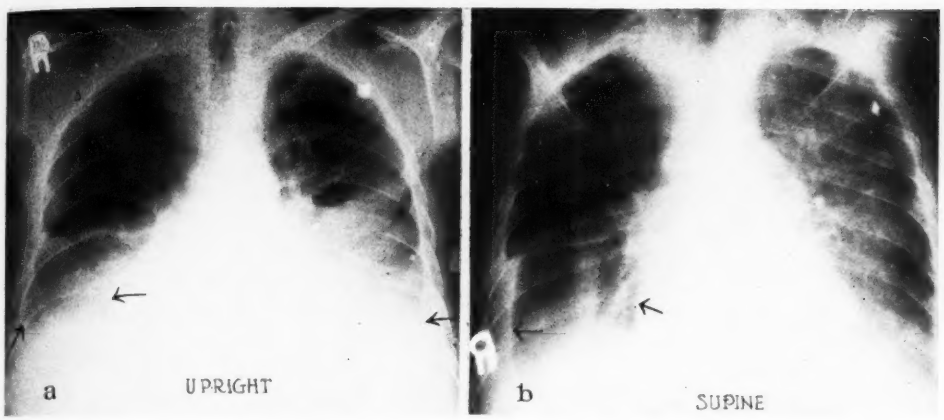


Fig. 4. Case of cirrhosis of liver, ascites, and mediastinitis with bilateral pleural effusion. (*A*) Upright roentgenogram, showing fluid on the right side extending along the periphery (lateral arrow) and into the interlobar fissure. Note the large shadow, apparently a part of the heart (medial arrow), simulating a very much enlarged right atrium. On the left side, there is a more characteristic picture of pleural effusion. (*B*) Supine position, showing disappearance of shadow in the region of right heart, with increase of fluid at the periphery and in the interlobar fissure; this indicates that the mediastinal shadow in the upright position was due to fluid in the mediastinal pleural space. On the left side the fluid has spread out in a thin layer throughout the thorax.

denser shadows over the diaphragms, at the costophrenic angles, at the periphery on the right, and, remarkably enough, over both apices (upper arrows), extending into the superior portion of the mediastinal pleura on both sides. In the lateral decubitus positions the fluid extends into the inferior portion of the chest on each side. Thus, the fluid on the left is almost hidden by the heart shadow when the patient lies on the right side (Fig. 1-*C*), while the right-sided effusion forms a crescent-shaped shadow in the inferior costal gutter. Exactly the reverse occurs when the patient's position is reversed (Fig. 1-*D*) and the left side is down. In the second case (Fig. 2), the characteristic shifting of the fluid from over the left diaphragm to the inferior costal gutter, presenting a rather flat superior surface, is brilliantly demonstrated. In Figure 2-*B*, one arrow points to the diaphragm, which, in this position, is now clearly seen; although in the upright position it appeared to be very high due to the accumulation of fluid over it, in this position it is at the same height as the right diaphragm. The inferior arrow points to the fluid which has shifted, with the change in position of the patient, from above the diaphragm to the inferior costal gutter. In the third case (Fig. 3), almost exactly the same phenomenon is demonstrated except that it is on the right side and there is a considerably greater accumulation of fluid. In the fourth case (Fig. 4), the change in position from upright to supine produces a marked shifting of the fluid. This was largely held in the mediastinal pleural space and simulated an enlarged atrium in the upright position; in the supine position (Fig. 4-*B*), the right border of the heart can be clearly made out (medial arrow) and shows no particular enlargement. A large quantity of the fluid has spread to the periphery of the lung and as a thin layer throughout the thorax as well. It should be noted that the fluid on the left side also spreads out with this change in position, so that there is a diffuse thin shadow throughout the left chest quite different from that observed in the upright position. In the final case, the shift in position from upright to supine again causes a disappearance of the shadow in the right mediastinum which was shown in the upright position (Fig. 5-*A*); there is a diffuse thin layer of fluid clearly demonstrated throughout the thorax in the supine posi-

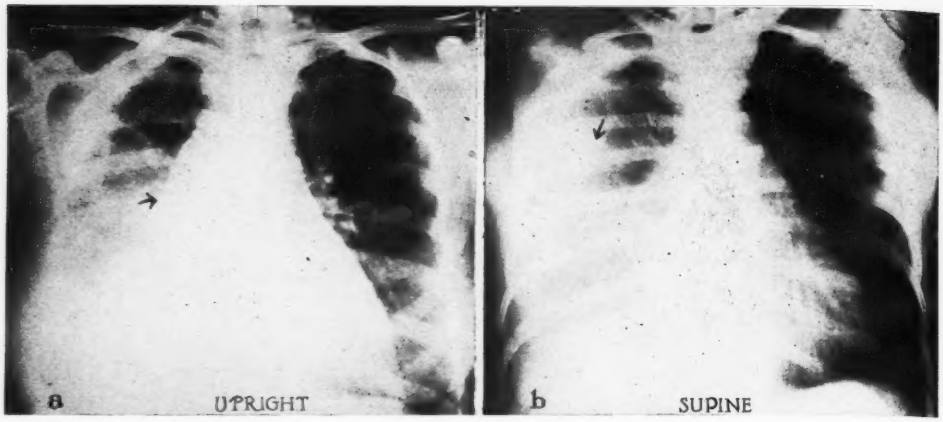


Fig. 5. Case of generalized carcinomatosis with fluid in the right pleural cavity. (*A*) Upright position. Typical shadow of fluid extending up along the periphery and into the interlobar fissure (upper arrow). Note the shadow along the right mediastinum resembling a mediastinal tumor or an enlarged ascending aorta (lower arrow).

(*B*) Supine position. Shadow in the mediastinum has disappeared and there is an increase in the evidence of fluid throughout the pleural cavity, indicating that the mediastinal shadow in Figure 5-*A* was due to fluid in the mediastinal pleural space.

tion (Fig. 5-*B*). Similar changes are demonstrated in Figure 1 of a previous publication (3), and in Figure 5 of another publication (4), both of which cases might well have been confused with some other condition because of the atypical distribution of the fluid in the upright position.

It is evident from a consideration of these cases that fluid not infrequently may distribute itself most atypically and produce bizarre appearances which readily might lead to diagnostic errors. The effectiveness of the procedure of examining patients in a variety of positions, in the diagnosis of pleural abnormalities, is well demonstrated by these cases. The use of numerous positions, in my experience, is infinitely more helpful than the routine stereoscopic films of the chest so characteristic of American roentgenology.

The rather curious distribution which fluid usually assumes in the pleural cavity has been the subject of much speculation and research. A recent paper by Kaunitz (1) elucidates some of the theoretical considerations. Other studies on this point have been referred to in previous publications (3 and 4). The factors which affect the position of fluid in the pleural cavity are numerous, but, the liquid being so much heavier than the lung, gravity here, as elsewhere on the earth, exerts a most profound influence. This force, however, is greatly modified because of the peculiar physics of the pleural cavity and by other factors which come into play. The chief amongst these is the retractile power of the lung, a result of its elasticity. This accounts, in part at least, for the negative intrapleural pressure, and tends to produce the typical distribution of fluid described in the first paragraph of this paper. The retractile power of the lung varies with the distance from the hilum, its fixed portion. The costophrenic angle usually represents the greatest distance from the lung attachment, and hence the greatest retractile force is exerted there. This, together with gravity, accounts, in large part, for the tendency of fluid to accumulate first at this point. The tendency for fluid to extend along the periphery toward the apex is largely due to the greater retractile force at this point. It is not unusual, in my experience, to observe fluid extending well up to the apex of the lung without any appearing in the mediastinal portion. It is obvious that a change in the elasticity of the lung,

such as occurs with chronic passive congestion, pulmonary edema, chronic fibrosis, or consolidation, will reduce the retractile power considerably. The result may be that gravity becomes the determining force, and the characteristic curved, concave level may be completely lost.

Another force of consequence is the tendency toward cohesion between the pleural surfaces producing capillarity. This again tends to cause a rise in the position of the fluid, contrary to the effect of gravity, but may also act to draw fluid into the smaller intrapleural spaces such as those between the lobes. The effect of capillarity on the position of fluid is similar to that of the retractility of the lung, except that capillarity will be exerted in the anterior and posterior pleural spaces which are medial—hence close to the hilum of the lung—as well as in the lateral portions, in which the retractility of the lung exerts its greatest influence. In the case of this cohesive force of the pleura, such changes as edema, inflammation, fibrosis, or adhesions of the pleura itself may modify its effect materially.

A third factor of some importance may well be the surface tension of the fluid itself. The character of the fluid, whether transudative, simple exudative, or purulent, may be more potent in this regard than has hitherto been considered. It is interesting to note, for example, that those effusions which present a bizarre or unusual distribution are usually transudative in nature. Furthermore, it would seem to be of some significance that in three of the cases observed the patients were suffering from a lipoid nephrosis. In such individuals there is an excess of lipoids, both in the blood stream and in the body fluids; likewise, the transudates, which, under such conditions appear everywhere in the body, contain an excess amount of lipoids, often having a milky appearance. The surface tension of fluids containing lipoids is much lower than that of ordinary serum, hence it is possible that this was an important factor in producing this rather unusual distribution of the pleural effusion.

The entrance of gas into the pleural cavity will, obviously, modify all these factors tremendously, permitting gravity to be the only determining force. The gas collapses the lung, thus eliminating the force of lung retractility. The pleural surfaces are widely separated by the interposition of the gas, thus eliminating the force of capillarity. Finally, the surface tension of the fluid is of no great importance when the pleuræ are separated in this fashion. The effect of pneumothorax on the shadow of fluid in the pleural cavity in producing a flat upper surface is, of course, very well known. Contrary, however, to the opinion of Korol and Scott (2), pneumothorax is certainly not the only means by which the usual distribution of a pleural effusion may be modified. Any one of the changes noted in the previous paragraph may, to a degree at least, simulate the effects of gas in the pleural cavity. Any one of these changes, furthermore, is likely to be present in patients who have developed a pleural effusion.

It seems apparent, then, that pleural effusions, particularly transudates, under certain conditions, may present a bizarre roentgenographic appearance in the upright position. The roentgen findings may simulate a number of other conditions and diagnostic error may result. Examinations made with the patient in a variety of positions will usually serve to elucidate the actual condition and permit a correct diagnosis to be made. Furthermore, some evidence as to the nature of the fluid may thus be inferred.

SUMMARY AND CONCLUSIONS

The majority of cases of pleural effusion give a characteristic roentgen appearance, due to physical factors which oppose the force of gravity.

In certain cases, particularly those with transudates, the fluid may present a very bizarre appearance, due, probably, to a change in the factors which affect liquid distribution in the thorax.

The entrance of gas into the pleural

cavity is not the only factor which will change the usual distribution of pleural fluid.

Roentgen examination in a variety of positions will clarify any doubt as to the diagnosis which may be aroused by the unusual position of the fluid.

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PULMONARY MYCOTIC INFECTIONS[1]

By RAY A. CARTER, M.D., *Los Angeles*

From the Department of Roentgenology, Los Angeles County Hospital

VARIOUS systemic mycoses have been found usually so similar to tuberculosis, clinically and pathologically, that they could be positively diagnosed only by identification of the organism. They have so much in common that mycosis in general, not a specific one, is often to be suspected. Since all infections cannot have exhaustive bacteriologic study, early recognition of mycotic disease will depend on alertness to suspicious but not distinctive features which single out cases for such investigation.

The comparatively few roentgen studies have also demonstrated nothing pathognomonic. These diseases may be thought too rare for routine consideration in roentgen diagnosis. There is persistent belief, however, that many pass unrecognized. Also, most reported cures have followed early diagnosis as local infections, primary pulmonary attacks, or early in the metastatic stage. The best, if not the only, opportunity for cure is before massive infection, profuse metastases, or chronic attenuated but intractable widespread involvement. Much is at stake in early diagnosis which is difficult and useful.

Intrathoracic involvement is usually present, and a pulmonary onset is frequent. Roentgen manifestations, however inconclusive, may be of service if they promote bacteriologic study. It may then be justifiable to attempt this survey, comparing coccidioidal granuloma, of which mycosis alone we have a significant number of cases, with tuberculosis and other mycotic diseases, through our own few cases and through the literature. Unfortunately, roentgen detail is not stressed in the literature. Also, these diseases appear almost as varied in roentgen manifestations as tuberculosis itself. Significant predilections and associations only may be hoped for.

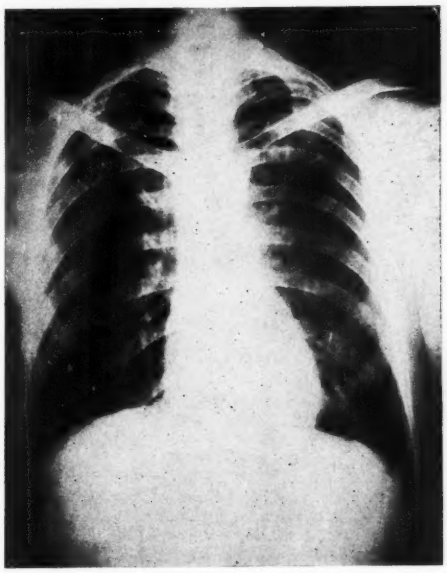

Fig. 1. Unusual coccidioidal granuloma. Apical linear fibrosis, small thin walled cavities; no mediastinal or hilar adenopathy.

A description of the pathogenic fungi is not necessary here; classifications and nomenclatures disagree. Differing strains and pleomorphic forms occur. Blastomyces, actinomyces, aspergilla, and monilias are genera, the individual species of which differ structurally, culturally, and in pathogenesis. These groups, however, may be considered as entities until more standardized botanical classification and adequate clinical material justify closer distinction. Subject to differing opinions, identification of the organisms is available from experienced bacteriologists and mycologists.

COCCIDIOIDAL GRANULOMA

Primary infection is cutaneous, pulmonary, or rarely, oropharyngeal. The diges-

[1] Presented before the Radiological Society of North America, at the Twenty-first Annual Meeting, in Detroit, Dec. 2–6, 1935.

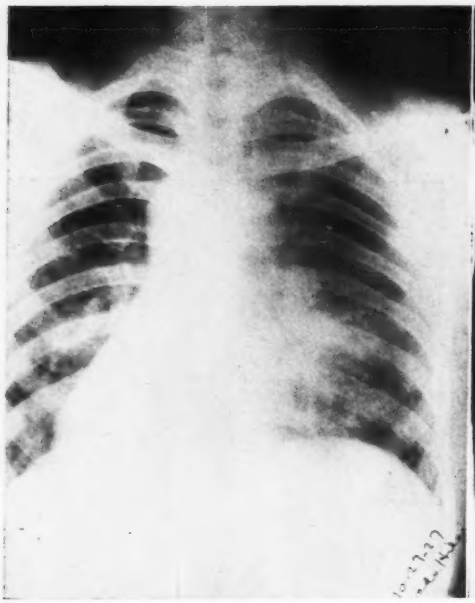

Fig. 2.

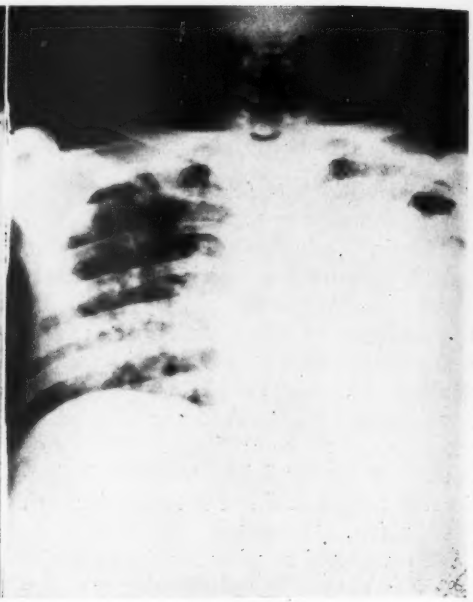

Fig. 3.

Fig. 2. Typical coccidioidal granuloma. Mediastinal and hilar caseous adenopathy; vague miliary lesions; inferior angle of the right scapula destroyed.

Fig. 3. Coccidioidal granuloma, acute type. Massive consolidation; "blotchy" nodal lesions; very rapid advancement.

tive tract is practically immune. Pulmonary onsets are very common; their full proportion is not known because they may subside and become significant only by later metastatic manifestations.

The disease is essentially granulomatous, its basic lesion a tubercle, resembling that of tuberculosis. Lymph glands are selectively involved. Abscess is common. The lesions are quite invasive, but blood vascular metastatic dissemination is more prominent than spread by contiguity. Common manifestations of dissemination are as follows: cutaneous nodes, ulcers, and sinuses; subcutaneous and deep abscesses, and local destructive lesions of bone and joint (1).

Intrathoracic lesions include caseous enlargements of tracheobronchial and mediastinal glands; infiltrations, diffuse miliary, nodular, and nodal; consolidations, small to massive; abscesses; pleural exudates, local or general, and associated lesions of thoracic, osseous, and soft structures.

The films of the chests in 60 cases are compared with 60 films of tuberculosis, serially chosen. Gross predilections only can be trusted from our limited series of the mycosis, and can be most simply shown by the equal numbers of films. Roentgen manifestation in the two series of films are expressed in a coccidioides-tuberculosis ratio, as 6 to 29.

Air-containing cavities, 6 cases to 29, were mostly of the small acute type, not over 2 cm. in diameter, and like recent excavations of small tuberculous caseations. They were also fewer per film; not more than two were seen in one case of coccidioides. Their small numbers and more often their absence in films, which, if tuberculous, would have been expected to have multiple cavities, was striking. No large fibrous-walled cavities were seen. Two films had small round cavities also not over 2 cm. in diameter. One of these was an exceptional case, to be discussed later (Fig. 1). This sparsity of cavities is in spite of numerous necroses reported at

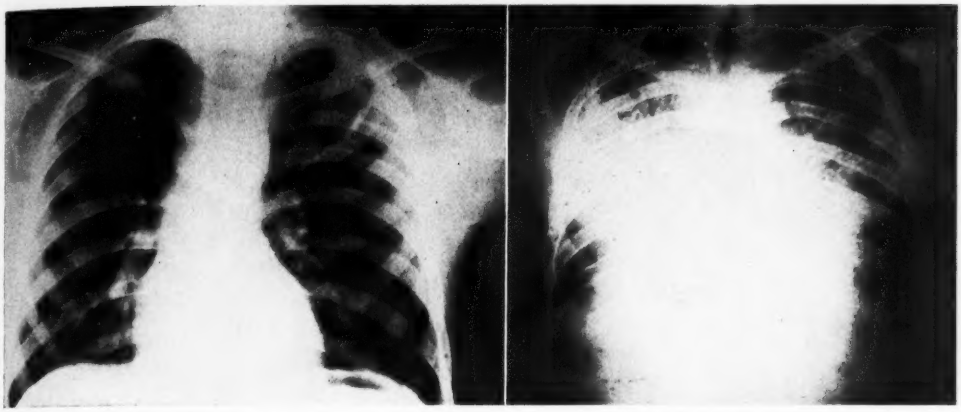

Fig. 4. Fig. 5.

Fig. 4. Coccidioidal granuloma. "Cloudy" apical infiltration; no obvious adenopathy; destructive lesion, left second rib.

Fig. 5. Coccidioidal granuloma, acute. Almost confluent vague miliary involvement; caseous adenopathy.

autopsy. Apparently, bronchial drainage is not readily established.

Mediastinal adenopathy, 50 cases to 14, was more frequent and more advanced in coccidioides (Fig. 2). Only three tuberculous adenopathies in degree approached the average of the mycosis. Many coccidioidal enlargements were gross.

Hilar thickening, 46 to 30, was slightly more common and definitely more advanced in the mycosis, and generally paralleled a mediastinal enlargement, indicating a general adenopathy.

Thickened large truncal shadows, 25 to 37, and thickened finer linear interweaving, 7 to 25, were more frequently local in both diseases. Passing toward the periphery of the lung, thickening of the normally visible pulmonary structures was proportionally less in coccidioides. Generalized peribronchial involvement, resembling the type described by Pinner (2) as non-miliary homatogenous tuberculosis, was seen in ratio 1 to 3, the numbers being too small to be significant, except that they agreed with the trend above stated.

Full consolidations, 9 to 29, were more common in tuberculosis. In both cases they were usually confluences of miliary, nodular, or patchy infiltrations, but were occasionally massive (Fig. 3).

Apical or subapical peripherally accentuated lesions, 20 to 54, were definitely fewer in coccidioides, and were more often of the diffuse cloudy type seen in the very early tuberculous lesion (Fig. 4). They did not give the appearance of an older parent lesion from which others had developed.

Descending spread from an older apical or subapical lesion was 0 to 24. In no case did we see a clear record of descending bronchiogenic spread from an older subapical involvement.

Acinous nodose manifestations, or mulberry clusterings of discrete fine nodular densities were 0 to 18. This common manifestation of bronchiogenic tuberculosis was absent.

Coarse rounded nodular densities, 2 to 8, were too few to establish predilection.

"Blotchy" bronchopneumonic densities, 2 to 22, were usually local in tuberculosis. A few tuberculous and both coccidioidal cases had extensive dissemination of this type (Fig. 3). In either disease, these lesions may develop very rapidly. More films in the terminal coccidioides would have shown more lesions of this type.

Linear fibrosis was 6 to 32. One is inclined to attribute those seen in coccidioidal granuloma to an incidental minor tuberculous fibrosis. One case with bilateral

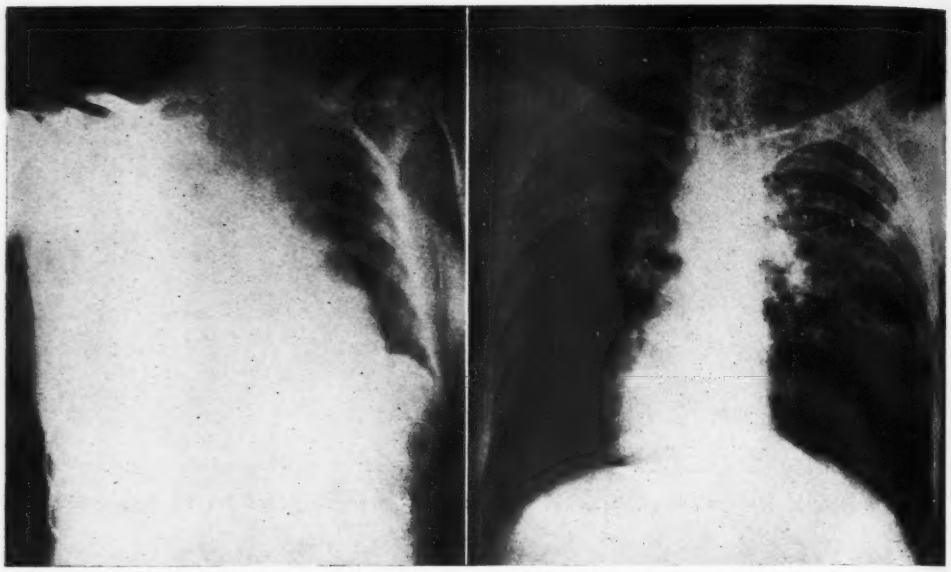

Fig. 6. Fig. 7.

Fig. 6. Coccidioidal granuloma. Pleural exudate, general and encapsulated.
Fig. 7. Blastomycosis. "Blotchy" bronchopneumonic lesions; apparent descending spread; large thin walled cavity; adenopathy not prominent.

apical linear fibroses, and two small thin-walled cavities had numerous sputum examinations, acid-fast negative (Fig. 1). Coccioides immitis was recovered by animal inoculation. The patient, never very ill, did well on tuberculosis management with no antimycotic medication. It is considered a fibrotic coccidioides but is entirely at variance with our other cases.

Mediastinal and hilar retractions toward contractive or apical or subapical lesions, were 1 to 25. The one coccidioidal retraction was inconsequential. This common tuberculous manifestation was practically absent.

Miliary manifestations (Figs. 2 and 5), inferring blood vascular disseminations, were 26 to 1. These are much more indefinite on the film than in tuberculosis. Supported by its almost constant presence at autopsy, one infers it from an indefinite ground-glass smeariness of the lung-field. Only in one case were the miliary lesions as sharply discrete as in the average tuberculosis.

Lesions wholly or predominately basal were 4 to 1. The numbers are too small to establish a predilection but are in keeping with a tendency to resemble the more acute forms of tuberculosis.

Pleural lesions were 13 to 18. The majority in tuberculosis were well organized local adhesions; those of coccidioides were local or general fluid or more acute plastic exudates (Fig. 6). Some were local, secondary to destructive lesions of the ribs.

Calcified tracheobronchial glands, 4 to 11, were no more frequent in coccidioides than in miscellaneous chest films.

Parenchymal calcifications were 1 to 16. The one seen in coccidioides resembled a classical "Ghon."

Destructive lesions of bone, evident on the chest film, 13 to 0, were seen in the ribs, scapulæ, clavicles, and spine (Figs. 2 and 4). While such lesions will occasionally be seen in tuberculosis, the incidence is strikingly less.

The less advanced and more chronic forms of coccidioides tend to combine adenopathy with minor or absent pulmo-

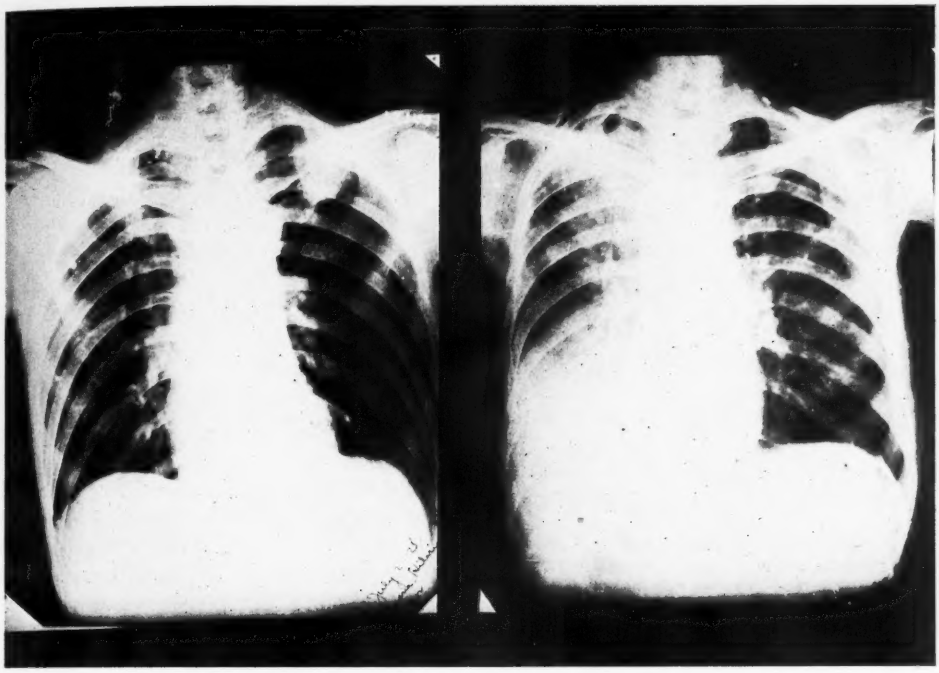

Fig. 8. Actinomycosis, pneumopulmonary. Gradual growth by contiguity, from a small subapical consolidation to a massive lesion occupying the greater part of a lung.

nary lesions. The more acute and more advanced cases feature advanced enlargements of the glands, with cloudy densities or vague miliary appearances (Fig. 5). The disease resembles the more acute and juvenile types of tuberculosis. Juvenile coccidioides tends to resemble the more florid juvenile or infantile tuberculosis. The absence of calcification is an exception to this trend.

Any of the mycotic appearances seen could have been due to tuberculosis. Even when the predilections are combined, as they frequently are, they will be seen as tuberculosis more often than as coccidioides. However, the chance of mycosis will often be greatly heightened, especially in the adult.

Roentgen findings, heightening the chance of the mycosis, are: mediastinal and hilar adenopathy in the adult; vague miliary infiltration; absence of descending spread, of cavities in advanced lesions, and of elder subapical lesions; destructions of bone or abscess in the thoracic wall, or entirely extrathoracic lesions as previously mentioned (1).

Manifestations, absent or infrequent in the mycosis and decreasing the chance of its presence, include the following: linear fibroses, except as they may be present incidentally; mediastinal or hilar retractions; air-containing cavities, particularly fibrous-walled, large round thin-walled, or numerous small acute cavities; parenchymal calcifications; obvious descending spread; acinous nodose manifestations.

In persistent absence of the tubercle bacillus, if these types of involvement are eliminated as unlikely to be coccidioidal, a small proportion of tuberculosis-like chests are left as legitimate suspects.

Unfortunately, coccidioides is seldom suspected in the stage of primary pulmonary invasion, when the chance of cure is best. A "cold," "influenza," and "pneumonia" may recover tardily or incompletely. Medical care is sometimes not ob-

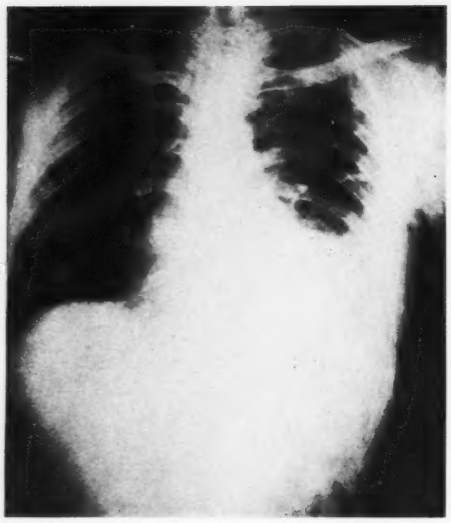

Fig. 9. Actinomycosis, pleuropulmonary. Basal clinical empyema, with obscured consolidation and abscess; clinical diagnosis, empyema.

tained and a film is seldom made. Eventual fair recovery occurs and suspicion is not aroused till metastatic infection appears. If the attack is acute and progressive, metastatic manifestations appear early. All that may be expected in the early primary stage is diffuse cloudy parenchymal densities, compatible with early tuberculosis or unresolved bronchopneumonia. If the sputum studies in such cases included a sodium hydroxide mount, an occasional case should be recognized. Laboratory infection has been identified in this stage and cured. It is probable that spontaneous recovery occurs, as inferred by Chamberlain in his discussion (3).

BLASTOMYCOSIS

The most frequent involvement is a characteristic granulomatous lesion, spreading by contiguity in the skin, with only rare systemic metastases.

The occasional systemic infections are strikingly like those of coccidioidal granuloma. They arise primarily in the lung or skin.

The disease is granulomatous; it has a marked tendency to wide metastatic dissemination, and is moderately invasive. Ulcers of the skin, soft tissue abscesses, osseous destructions which may secondarily involve joints, and caseous adenopathy all are common features. The gastrointestinal tract is practically immune.

Roentgenographically, the pulmonary lesions are tuberculosis-like. Dunham has described, and Brooksher (5) successfully used in two cases the diagnostic point of "a characteristic studding which follows one or more of the main trunks, but usually does not quite reach the periphery, from which they are separated by an area of clouded lung density." This studding is calcific.

Nodular manifestations, miliary to coarse, mediastinal or hilar adenopathy, and abscesses are common. Cavities, communicating with a bronchus, are described (4). We have one case which has a round, thin walled air-containing cavity, like those of tuberculosis. Apparent descending spread of a "blotchy" bronchopneumonic type is present (Fig. 7). Consolidations are common, although frequently the lung is described as crepitant throughout. Occasional apical retractions may be expected from fibrotic apical consolidations (4). Fibrosis in sheets and strands is mentioned. Pleural lesions are frequent, often well organized and adhesive. It apparently parallels a case described pathologically by Stober (4), and illustrated by cross-section by Boughton and Clark (6). Associated lesions of bone are frequent.

It may be tentatively said that any individual film of the chest in this disease could be diagnosed as tuberculosis. There should be a higher incidence of miliary lesions, adult adenopathy, and associated bone pathology in blastomycosis. The disease may more closely approach tuberculosis in major manifestations than will coccidioides—more fibrosis; relatively less adenopathy; more visible cavities, and more descending spread. The resemblance to more acute or juvenile types of tuberculosis is probably less complete and less consistent than that of coccidioides. The

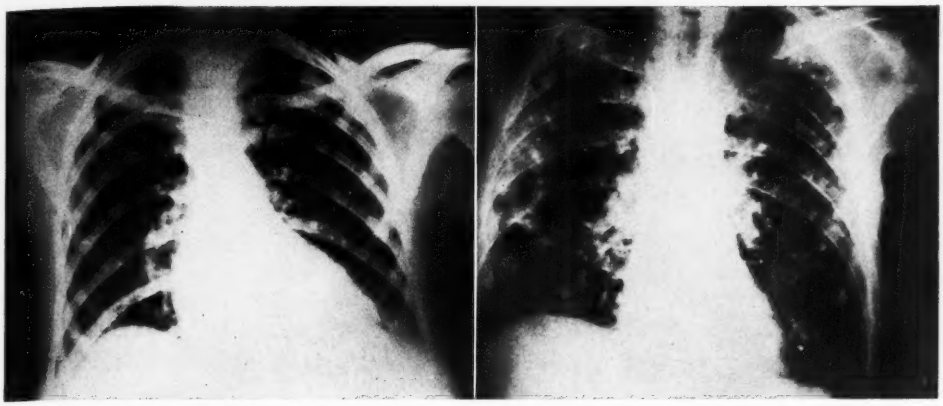

Fig. 10. Fig. 11.

Fig. 10. Actinomycosis. Scattered hazy nodal lesions.
Fig. 11. Actinomycosis. General peribronchial fibrosis and scattered hazy nodes; pleural involvement, plastic and scant.

stage of primary pulmonary invasion is not often recognized.

ACTINOMYCOSIS

The primary infection may be pulmonary, cutaneous, oral, esophageal, or intestinal. Involvement of the digestive tract is common, in contrast to blastomycosis and coccidioides.

Pathologically, the disease is a granuloma, having marked predilection to fibrosis and abscess. Metastatic spread is less frequent and less extensive than in coccidioides and blastomycosis. Direct invasive extension is more prominent. Thus, the disease tends to produce one or a few extensive lesions rather than numerous scattered small foci, as in the other mycoses.

Abscesses, cutaneous, subcutaneous, or deep, are prone to burrow extensively. Lesions of the bone and joint occur, which may be metastatic but are frequently extensions from adjacent soft tissue involvement.

Pulmonary lesions have been classified by Naussac (7) as broncho-actinomycotic, pleuropulmonary, and pneumopulmonary. The first may be considered an actinomycotic bronchitis, somewhat akin to the mild pulmonary mycoses, bronchomoniliasis and aspergillosis. In this rare form, the usual invasive spread through pulmonary structures does not occur. The pleuropulmonary type is featured by fibrosis, abscess, and granulomatous consolidation, involving both pleuræ and adjacent lung so that they are "glued" together by dense fibrotic tissue to the degree that they are merged into one inseparable mass. Such lesions may be massive or local.

The pneumopulmonary type, starting in the lung itself, develops to consolidations, usually massive, combined with abscess, miliary or nodular infiltration, and fibrosis. The pleura may or may not become involved. Discrete nodular involvement may occur without consolidation.

As Naussac has stated (7), the result in the thorax is apt to be much the same in the end, regardless of origin or original type. Lesions in the thoracic wall, cervical tissues, or esophagus, burrow into the thorax, involving as they go, the ribs, pleura, lung, mediastinum, and pericardium. Lesions starting in the lung will spread to the pleura, thoracic wall, mediastinum, pericardium, diaphragm, etc.

Roentgenographically, there is a preponderance of actual consolidations, local or massive. Abscesses may or may not be demonstrable. Pleural thickening is often extreme. Empyema occurs as local encapsulations or general effusion. A clear record of extension to or from the thoracic wall is often obtained. Discrete nodular involvement, from miliary to coarse, may

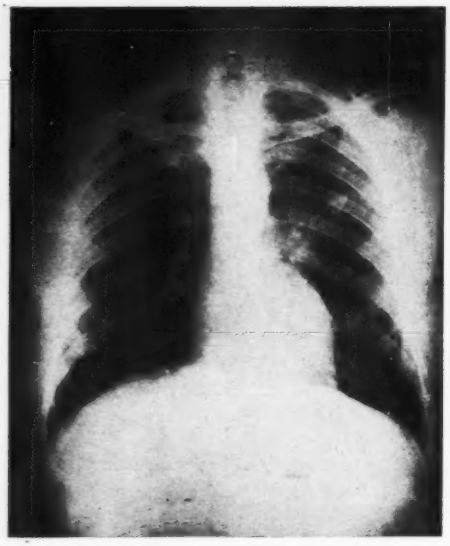

Fig. 12. Torulosis. Small circumscribed consolidation; associated destructive invasive lesion at the knee.

be present, simulating miliary tuberculosis, or, as cited by Pancoast and Pendergrass, nodular pneumoconiosis (8). Widespread interstitial fibrosis without consolidation may occur.

Our 9 cases with intrathoracic involvement appear to correspond fairly well to the types usually described (10 and 11). Six had a primary pulmonary attack. Three had origins, respectively, cutaneous, laryngeal, and cecal. None had invaded the thorax from without, which is exceptional.

Three cases had massive consolidation of the pneumopulmonary type. Two of these were metastatic from extrathoracic lesions, one, primary in the lung; one of them had advanced pleural thickening; one had a record on films of contiguous spread from a small apical consolidation to massive consolidation of almost an entire lung. This type of spread is not common in tuberculosis (Fig. 8).

Four cases were of the pleuropulmonary type. They had local basal empyemas, with pleural thickenings and local pulmonary consolidations obscured by the pleural involvement (Fig. 9). Three had local abscesses, not air-containing and not shown on the films. All of these had a respiratory attack followed by apparent empyema, which was the clinical diagnosis before the organism was demonstrated. Tuberculosis was not simulated roentgenographically.

The two remaining cases were particularly tuberculosis-like. One featured small, vague, sparsely scattered nodes, a late metastatic spread from an advanced abdominal lesion from which an organism was recovered (Fig. 10).

One case had widespread peribronchial thickening, extending to the finest divisions, plus scattered, vague, hazy nodes. It gave the impression of widespread interstitial fibrosis (Fig. 11).

Five of the nine involvements were unilateral fibrosis, in keeping with the predominance of invasive spread in this disease. Several involved the thoracic wall by extension from within.

Suspicious of actinomycosis as against tuberculosis are a predominance of plastic pleural or empyemic manifestations; directly spreading invasiveness of consolidations; extensive lesions confined to one side of the thorax, and particularly a clear record of extension through the thoracic wall, either from within or without.

Recognition in the stage of primary pulmonary attack is the exception.

STREPTOTRICHOSIS

Streptotrichosis may be considered to be involvement by the allied organisms, sporothrix, streptothrix, and pseudoactinomyces (12). Skin, mucous membranes, or lung may be primarily affected. Cutaneous lesions may long remain local or give rise to regional adenopathy. Pulmonary involvement is usually primary (Bridge, all of 13 cases, 13). It may be acute or chronic; the acute form may arise by metastasis from a cutaneous focus.

Pathologic manifestations include consolidation with caseation, bronchopneumonia, pleurisy, bronchitis, abscess, miliary and nodular lesions.

Roentgenographically, the disease may

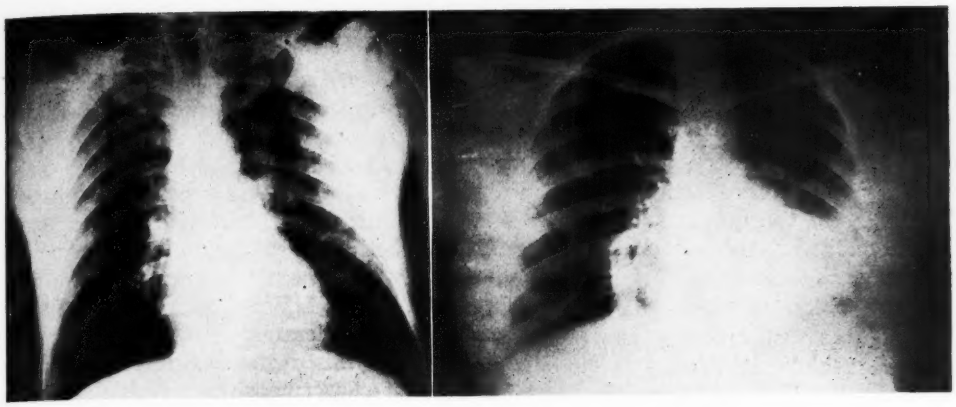

Fig. 13. Fig. 14.

Fig. 13. Moniliasis. Thickening of hila, truncal shadows and peribronchial markings.
Fig. 14. Moniliasis. Contractive basal consolidation which later decreased in size; lipiodol instillation showed bronchiectasis.

be said to resemble actinomycosis more than it does tuberculosis or other mycoses. As cited by Pancoast and Pendergrass, miliary or nodular forms occur in sporotrichosis (8). Such manifestations are readily attributable to tuberculosis.

TORULOSIS

The portal of entry in this disease is more obscure than some because of its usually chronic character. Primary respiratory onset is frequent (14).

The disease may be local or general: the former is particularly chronic (14). In the latter, eventual fatal meningeal involvement is usual (14 of 19 cases, Stone and Sturdivant, 16). Lesions of skin and bone are rare. The tongue (17) and pelvis (15) have been involved.

Pulmonary involvement is usually chronic. Consolidations, essentially nodular in structure, are frequent (16 and 18). There is a strong tendency to fibrosis, but little to caseation. Abscess is not the rule but may occur (19). Pleural involvement is usually either absent or scant. Discrete nodular involvement, miliary to coarse (14), is seen and may occur with or without consolidation. A form resulting in general thickening of peribronchial structures occurs (17). Adenopathy is not stressed in autopsy reports. Air-containing cavities appear to be infrequent. Tuberculosis-like descending spread from an older subapical lesion is not usually to be inferred from reports, although it may be assumed from the excellent illustrations of serial films in the case of Hardaway and Crawford (14). These film illustrations appear to show also a progressive hilar thickening, but without obvious mediastinal adenopathy.

The lesions would probably be, with rare exceptions, roentgenographically compatible with a diagnosis of tuberculosis. Air-cavities, calcifications, apical and hilar retractions, and marked pleural thickening would appear to speak against this disease. Pleural lesions of consequence are less frequent and less pronounced than in most other mycoses. Associated extrapulmonary involvement, with the exception of meningitis, is not prominent and is not apt to occur in the skin and bone. However, we have seen one case (that of Dr. J. C. Wilson), which combined a small consolidation in a lung with an advanced invasive lesion at the knee (Fig. 12). The disease is neither strongly invasive or profusely metastatic. Cases resembling severe juvenile tuberculosis or combined glandular and miliary coccidioides should be rare, though one acute miliary case of Hirsch and Coleman (20) may resemble them. From a pathologic description of the miliary lesions they would be expected to be vague in outline. The report of that case con-

tains no reference to the marked caseous adenopathy which would have been expected in a comparable coccidioides.

MONILIASIS

The monilias cause local infection, most frequently in the oropharynx, as thrush. Occasional involvement is found elsewhere, as in the middle ear, nasal sinuses, vulvovaginal tract, or stomach.

In the lung, they may appear as secondary to symbiotic invaders in tuberculosis (21 and 22). They are occasionally found in pulmonary disease, tuberculosis-like, clinically and radiographically, or in symptomatic asthma, with no other organisms found in the sputum to explain the lesions. While moniliasis is considered a mild mycosis, the disease varies from mild chronic bronchitis to severe or fatal tuberculosis-like illness. Few reported cases have ended in death, so that autopsy proof of the infection is scant. One case (23), however, has established the infection as a sufficient cause of death and given some pathologic detail.

Pathology includes extensive bronchiectasis, pseudotubercles, fibrosis and granulation tissue, and peribronchiolar inflammatory changes with much fibrosis. Calcification and tuberculosis-like lesions were not seen. The pathology of this disease evidently ranges from that of a mild bronchitis to severe bronchitis, fibrous and granulomatous consolidations, diffuse infiltrations and peribronchial fibroses.

Roentgenographically, enough cases cannot be assembled to permit a detailed analysis of possible appearances. However, mediastinal adenopathy, calcific lesions, air-containing cavities, miliary or nodular manifestations or linear fibrosis would appear infrequent. Hilar thickening, peribronchial thickening, interstitial fibrosis, and bronchiectases appear to be common. Apical lesions, diffuse or consolidated, are common, but a subapical predilection does not appear to be present.

Our five cases appear representative of milder, more chronic manifestations of the disease.

Three had non-distinctive thickenings of hilar, truncal shadows and finer peribronchial markings, basally accentuated (Fig. 13). One had a small left basal consolidation with local pleuritis, which disappeared in two months. One had a large left basal contractive consolidation, which regressed slowly but incompletely in several months (Fig. 14). Lipiodol instillation demonstrated moderately advanced bronchiectasis in this region. No material mediastinal enlargement was noted.

Associated osteomyelitis or abscess of the thoracic wall would not be expected. One reported calcific studding recalls that described by Dunham (5) for blastomycosis (24). Mediastinal apical retraction has been illustrated (25).

Probably the roentgen pulmonary manifestations of the disease, beyond those of hilar and peribronchial thickening, could be due to bronchiectasis or tuberculosis. Cavernous appearances, excluding those of bronchiectasis, prominent miliary or nodular lesions, lesions of mediastinum or pericardium, or advanced pleural involvement would appear to speak against this disease.

COMMENT

Pulmonary mycotic manifestations on the film vary from case to case and from disease to disease, but will simulate closely some manifestation of the very variable disease, tuberculosis. On the whole, minority characteristics of that disease are simulated. These are seen so much more frequently as tuberculosis that they are properly recognized as tuberculosis-like. However, they are definite mycotic predilections. With persistent failure to find the tubercle bacillus, and with suspicious peculiarities of history, the chance of mycosis is sharply increased. Geographic location, occupation, associated extrapulmonary lesions, or characteristics of the film of the chest may direct suspicion to mycosis, or to a particular disease, such as blastomycosis, coccidioides, or actinomycosis. The ac-

curacy of these deductions is immaterial so long as they promote the decisive bacteriologic investigation.

Characteristics adding to the likelihood of a mycosis are:

(1) Outstanding mediastinal or hilar adenopathy in the adult.

(2) Miliary lesions, vague and profuse, associated in the adult with adenopathy.

(3) Absence or sparsity of dry air-containing cavities in advanced lesions.

(4) Extra-prominent pleural lesions, especially gross thickenings, local encapsulations, specially if associated with unusual pain or following a peculiar pulmonary attack.

(5) Absence in the adult of an obviously older apical or subapical lesion from which the remainder of the involvement may have spread bronchiogenically.

(6) Growth of a consolidation by contiguous spread.

(7) Lesions of bone or soft tissue abscess about the thorax.

(8) Extension of involvement through the thoracic wall, either from within or without.

(9) Hilar, truncal and peribronchial thickenings, with minor parenchymal changes associated with mild chronic clinical symptoms and profuse expectoration.

(10) Bronchiectatic manifestations.

(11) Fine discrete miliary or nodular manifestations, associated with fine peribronchial accentuation, in absence of a cause for pneumoconiosis.

(12) Cloudy parenchymal densities accompanying a subacute persistent respiratory attack, more indefinite than in the usual tuberculosis, which neither resolve or evolve into the more usual manifestations of tuberculosis.

Miscellaneous circumstances adding to the chance of mycosis when suspicious pulmonary roentgen signs are seen:

(1) Granulomatous nodes or ulcers in the skin, soft tissue abscesses, lesions of bone and joint, whether few and massive or scattered, multiple, and small.

(2) A preceding respiratory attack with slow or incomplete recovery, or even with good recovery, followed in a few weeks or months by pulmonary or extrapulmonary manifestations as described.

(3) Terminal meningeal symptoms. These do not point to tuberculosis, but are relatively more frequent in mycoses, particularly blastomycosis, coccidioidal granuloma, and torulosis.

(4) Geographical location. Coccidioidal granuloma will be suspected in California when blastomycosis would be considered in the Middle West; 7 to 19 reports of torula infection were from California (16). All mycoses are more frequent in the tropics or subtropics.

(5) Occupations are usually those having exposure to dusts likely to contain spores of fungi. Coccidioides is favored by close contact with soil and its products; actinomycoses by contact with hays and grains. Monilias are widely distributed in Nature.

Tuberculosis-like manifestations on the films, less likely to be mycotic, are as follows:

(1) Dry air-containing cavities, particularly if large, multiple, or fibrous walled. This is with the reservation that small and sparse cavities are occasionally seen in coccidioides, large thin-walled cavities in blastomycosis.

(2) Linear fibrotic subapical involvement, except as it may be incidentally present in coincident fibrotic tuberculosis.

(3) Mediastinal and hilar retraction toward an apical lesion unless there is massive consolidation.

(4) Parenchymal calcifications, except as they may be incidentally present, remembering Dunham's peribronchial studding in blastomycosis.

(5) Miliary involvements, sharply discrete and without adenopathy.

(6) Slowly scattered descending spread from a subapical lesion, particularly if associated with finely stippled acinous nodose appearances.

Obviously, roentgen characterization of pulmonary mycoses must at this stage be

tentative, subject to many exceptions and inaccuracies. Only by detailed study of the original films of known mycoses in volume can any degree of accuracy be attained in their roentgen diagnosis.

1200 State St.

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PRIMARY CARCINOMA OF THE LUNG[1]

By D. E. EHRLICH, B.A., M.D., *and* H. A. HAUPTMAN, M.D., *New York City*

From the New York City Cancer Institute, Department of Hospitals,
Ira I. Kaplan, M.D., Director

IN a symposium, it is permissible to take time out to look over the ground and note the progress made in the subject under discussion. Our subject is divided into two portions: the first is a statistical study of the clinical material; the second is a general survey based upon our material which supplements the literature.

During a twelve-year period (from 1923 to 1935) out of 13,868 admissions to the New York City Cancer Institute, Department of Hospitals, 124 cases were diagnosed clinically as primary carcinoma of the lung. Of these cases, 51 were transferred near the termination of their illness from 20 hospitals in New York City. A gradual increase of incidence was noted in the past few years. Age incidence was greatest in the 40- to 70-year period.

TABLE I

10–20	20–30	30–40	40–50	50–60	60–70	70–80	80–90
1	1	6	33	54	20	8	1

It was much more common in males (107) than females (17). Nationality was not a factor, 17 countries being represented. Interestingly enough, Russia totalled 28, U. S. A., 23, and Italy, 16.

There were 46 types of occupation listed, among which number there were 10 housewives, 10 laborers, 9 tailors, and 8 carpenters. Of course, this is not at all significant.

Onset was gradual in all but seven cases. In these, two followed an accident, one came on with a "cold," two came after the "grippe," one was ushered in with a lung abscess, and one with marked acute pain.

SYMPTOMS

Cough (most common)	84
Pain	74
Loss of weight	69
Dyspnea	42
Weakness	37
Hemoptysis	28
Blood-streaked sputum	23
Expectoration	26
Abdominal symptoms	15
Night sweats	9
Hoarseness	11
Mass on chest wall	4
Tumor on chin	1
Hiccough	1
Previous pneumonia	2
Pain in hip	3
Heart palpitation	2
Submaxillary mass	1
Swelling of arm	1

CO-EXISTING HISTORY

War gas	1
Diabetes	1
Heavy smoker	2
Drug addict	1

One patient had encephalitis plus gastrectomy plus cholecystectomy plus coronary sclerosis.

PHYSICAL SIGNS

Dullness	102
Diminished breath sounds	87
Nodes, positive	49
Diminished fremitus	41
Râles	24
Lagging of chest	31
Abdominal changes	19
Clubbed fingers	14
Pleurisy	8
Lung atelectasis	9
Vocal cord changes	5
Skeletal tenderness	4
Chest wall vessels engorged	3
Horner's syndrome	3
Eye changes and choked discs	8
Mass in chest wall	3
Cardiac signs	2
Hip pathology	1
Chest sinus	2

X-RAY FINDINGS

Opacity	104
Lung collapse	19
Bone destruction	18
Pleurisy	18

[1] Presented before the Radiological Society of North America, at the Twenty-first Annual Meeting, in Detroit, Dec. 2–6, 1935.

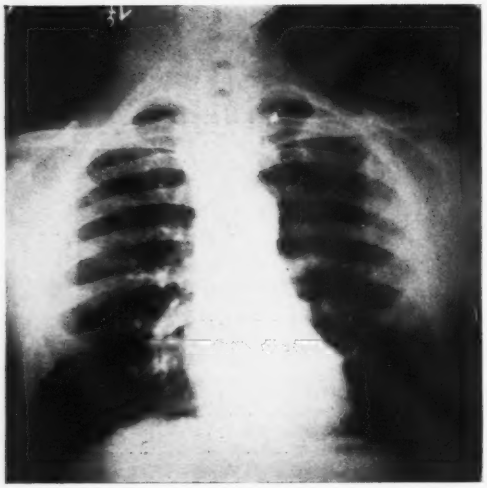

Fig. 1. Case 1. X-ray negative 5 weeks prior to death; autopsy showed tumor around the left main bronchus.

Metastases to bone	15
Metastases to lungs	3
Pneumothorax	5
Diaphragm elevated	5
Compression esophagus	3
Bronchiectasis	6
Radon implant in lung	2
Pneumonitis	3
Tuberculosis	12

Bronchography showed obstruction to the opaque mixture in two cases.

Biopsy revealed the following: Chest aspiration, positive in 7, and negative in 2; lung aspiration, positive in 5, and negative in 2; surgical excision, positive in 2, and negative in none; node excision, positive in 16, and negative in 5; rib excision, positive in 3, and negative in none; bronchoscopy, positive in 17, and negative in 6. There was a special case of a mass under the chin with report of metastatic squamous-cell epithelioma.

Therapy was as follows: X-ray in 45; radium in 8; selective pneumothorax in 5. Surgery: lobectomy in one; thoracotomy in one; phrenicectomy, pneumothorax, and lobectomy in one.

Autopsy reports revealed the following: In 1928, 1929, 1930, and 1931 no lung cancer cases were found; in 1932 there were three; in 1933 there were two; in 1934 there were three, and in 1935 there were five, making a total of 13.

Metastases to lung were found in 4 cases; to liver, in 3 cases; to the adrenals, in 4 cases; to hilus, in 3 cases; to retroperitoneal node, in 2 cases; to rib, in 1 case; to heart, in 1 case; to kidney, in 1 case; to skin, in 1 case; to bone, in 1 case; to mediastinum, in 1 case; to cervical nodes, in 1 case.

Of the 124 cases diagnosed clinically, 63 were proven by histopathology.

GENERAL SURVEY

In the past decade a voluminous literature has sprung up on "primary carcinoma of the lung," all of it showing an increase in the condition. Adler (1) very aptly remarked: "The failure of recognition of cancer of the lung has for a long time perpetuated the dogma of its rarity." Conversely, B. M. Fried (2) suggested the increase of incidence due to finer diagnostic technic. Fallibility of diagnosis in cancer study and an increase in the average life span into the cancer period are two important factors. Charles Bolduan and Louis Weiner (3), in a New York City Department of Health statistical analysis of the cancer deaths in New York City over a period of 30 years, show the increase in the registered death rate in the inaccessible cancers, and no increase in the "visible" cancers. The incidence of primary carcinoma of the lungs in the Soviet Union has risen in the last two decades to as high as 11.18 per cent of all carcinomas (4).

ETIOLOGY

Various causes have been suggested to explain the origin of lung carcinoma, which in general must depend on the same causes as carcinoma in the rest of the body. Inflammation, irritation, and injury are rightfully accused. Fried (5) reports 13 cases in men, in whom both tuberculosis and cancer were present in the same lung. Matz (6), Chief of the Medical Research

Subdivision, Veterans' Administration, Washington, D. C., reports a study of clinical and autopsy material of 942 World War veterans. Of these, 29 had combined tuberculosis and malignancy, a combination which co-existed in the same organ in 5 of the 29 cases. In three instances, active tuberculosis was demonstrated. This minimizes the importance that has been laid upon tuberculosis and war gas as common precancerous irritants. Graham (7) refers to 19 cases, or 10.7 per cent, which have been associated with malignant tumors in a series of 178 cases of pulmonary suppuration. Lickint (8) believes that tobacco is the chief cause in the majority of cases, and its effect probably concurs with other cancerigenous factors.

Lung cancer in miners has been reported from Schneeberg (9), Saxony, and Joachimstal (10). In Schneeberg, the etiology is considered due to either inhalation of arsenic and cobalt, or chronic inflammatory pneumonoconiosis caused by the inhalation of dust. In Joachimstal, the etiology is considered due to the inhalation of the radium emanation (10), or silicic acid (11) and its salts.

Fine and Jaso (12) report a case of coexistent carcinoma and silicosis at necropsy in a man who had been a stone cutter for 20 years. However, in a series of 69 cases autopsied at the Mallory Institute of Pathology, at the Boston City Hospital, Olson (13) found pneumonoconiosis in only 2.9 per cent.

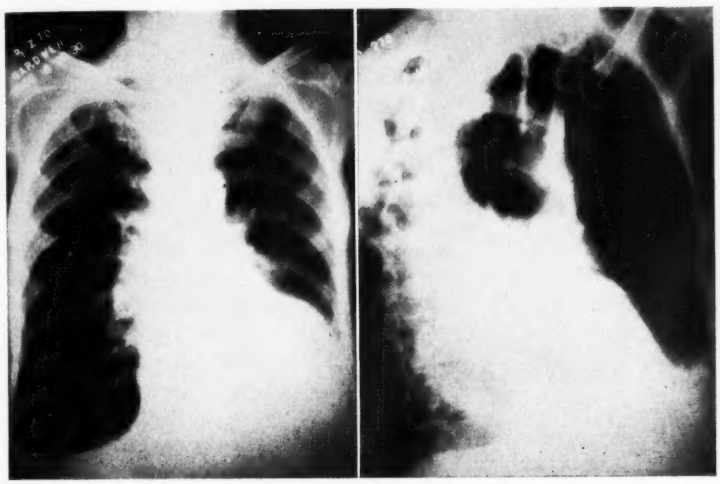

Fig. 2. Fig. 3.

Fig. 2. Case 2. X-ray (postero-anterior) showed left basal pleurisy.
Fig. 3. Case 2. X-ray (right anterior) showed left basal pleurisy and adhesive mediastinitis; tumor unsuspected.

The question of direct relationship between an isolated traumatic accident and malignancy is unsettled. The senior writer (D. E. E.) recalls a private case examined about ten years ago, following a crushing injury, for fractured ribs, at which time a central lung lesion was discovered, extending up from the right hilus toward the apex. Carcinoma was suspected; cerebral symptoms set in and eventually autopsy revealed a primary carcinoma of the lung with brain metastases. Other cases are on record, but the proof of coincidence, aggravation, or direct etiology is difficult and well-nigh impossible.

PATHOLOGY

The older writers classified the cancers as arising (1) from the epithelium lining the bronchi; (2) from the epithelium

that is said to line the pulmonary alveoli, and (3) from the epithelial cells that form the mucous glands. Adler (1), in his

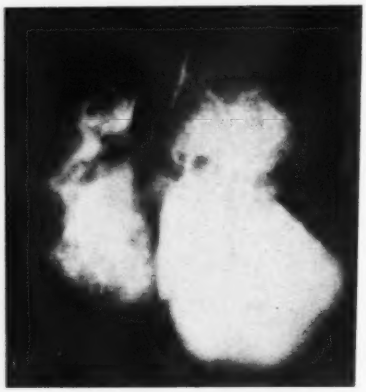

Fig. 4. Case 2. X-ray (postero-anterior) of lung specimen taken at autopsy, showing tumor in the left lower lobe with partial obstruction of the lobe.

memorable monograph in 1912, was of the opinion that cancer of the lung is a bronchial carcinoma, and Fried (2) came to a similar conclusion. Olson (3) also thinks that if non-bronchiogenic carcinoma of the lung exists, it is rare. Fried (2) remarks upon the Protean morphology of the histology as follows: "Finally the microscopic features of a fully developed pulmonary tumor will point to its histogenesis in exceptional cases only; the morphology of the neoplastic cells varies from one tumor to another (columnar, cuboidal, spindle-shaped, so-called 'oat cells,' squamous epithelial cells, basal cells), and even in the same tumor their form frequently varies from area to area. On the contrary, the arrangement of the cells is rather uniform, in most instances being that of adenocarcinoma." Fried suggests the following types of bronchiogenic carcinoma for consideration: (1) adeno; (2) medullary; (3) "oat" cell; (4) basal-cell epithelioma; (5) squamous-cell epithelioma.

The gross classification of the tumors as given by pathologists is unsatisfactory. Here, the roentgenologists have stepped into the breach, as pointed out by Heacock and King (14) naming Arnsperger, Jangeos, Barjohn, Otten, Carman, Kirklin and Patterson, Vinson and Farrell, in recognizing two main types: (1) hilar or (2) lobar, and a third type added by Kirklin and Patterson, the late type. Akin to this is the clinical surgical classification of Rabin and Neuhof (15), based upon the topography which is applicable to operative indications.

DIAGNOSIS

The onset was usually insidious and gradual, with the less common beginning of "heavy cold or influenza." Increasing tiredness or abdominal pain might be the sole indicator of the trouble before lung localization of symptoms. Cough was the most common initial symptom, with pain in the chest on the side of involvement appearing shortly after. Blood-streaked sputum or hemoptysis were less frequent. Dyspnea appeared in about half the cases, later on in the disease. Loss of weight and strength also came in the terminal stages. Lung atelectasis, pleurisy, or secondary infection also complicated the clinical picture, especially when on rare occasions they ushered in the disease. Metastases were not common and their symptoms discouraged diagnosis, especially when the primary malignancy was silent.

The physical signs varied with the type of disease. In the hilar non-circumscribed type, the physical signs were due to obstruction, partial or complete, with the associated atelectasis. In the peripheral, circumscribed, alveolar type, the physical signs were usually entirely absent or showed only some dullness. For the above reasons, the physical examination and diagnosis were not always clear-cut.

DIFFERENTIAL DIAGNOSIS

Differential diagnosis was beset with many difficulties. The stimulation by carcinoma of tuberculosis, abscess, pneumonoconiosis, fungus diseases, etc., in the lung and *vice versa*, with possible co-

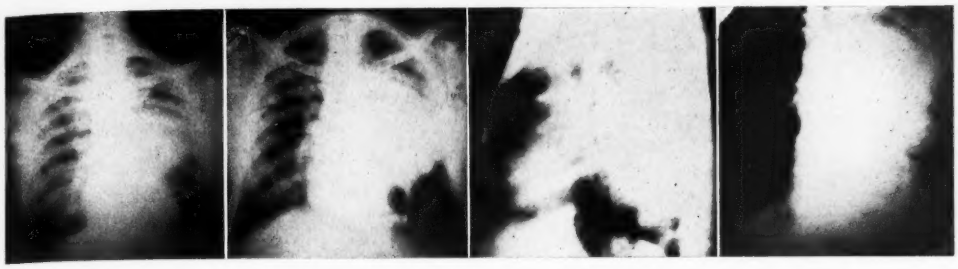

Fig. 5. Fig. 6. Fig. 7 Fig. 8.

Fig. 5. Case 3. X-ray (postero-anterior) from Health Department Clinic, showing localized central opacity about the left hilus. Film taken on May 18, 1934.

Fig. 6. Case 3. X-ray (postero-anterior) with selective pneumothorax, showing increase in size of opacity. Film taken on June 26, 1935.

Fig. 7. Case 3. X-ray (lateral) showed opacity posterior to mediastinum.

Fig. 8. Case 4. X-ray (postero-anterior) showed massive collapse of the left lung with mediastinal deviation to the left.

existence of the same, render this an especially interesting study. Kampmeier and Black (16) report a case of squamous-cell carcinoma of the bronchus, with secondary aspergillosis that overshadowed the carcinoma.

When possible, the following routine of diagnostic procedure was adhered to: history, physical examination, routine laboratory tests, x-ray examination, biopsy, bronchoscopy, bronchography, diagnostic aspiration, gradually increasing selective pneumothorax, direct thoracoscopy, and exploratory operation in selected cases.

X-RAY DIAGNOSIS

Frissell (17) very aptly summarizes the x-ray possibilities as follows: "The x-ray presents, according to the stage of the disease, no shadow, a picture of peribronchial infiltration extending from the hilus in early cases of carcinoma, a dense shadow involving the lobe in a scirrhous type of case, or an advancing atelectasis, sometimes involving the whole lung when both main stem bronchi are involved. A dense opacity due to fluid, discrete circumscribed shadows of the isolated lesion, or innumerable small shadows resembling tuberculosis of the miliary type, are other variants."

BRONCHOSCOPY

Jackson and Konzelmann (18) tabulate their data for the last four and one-half years as follows: 32 cases of bronchopulmonary cancer, in which bronchoscopic biopsy was confirmative. In all but three cases, the endobronchial lesion was thought to be primary. In addition to affording a means of diagnosis, bronchoscopy will give the surgeon "a definite evidence regarding the level at which the lobe or lobes must be amputated to reach the upper limits of the tumor" (Churchill). After roentgenographic localization of the lesion in both planes, the bronchoscope is passed down to the suspected area and the bronchial orifices are inspected. If fungating tissue is found in any of them, removal of an ample amount is easy. If there is no definite involvement of the bronchial wall, but only a compression or bulge, biopsy should be postponed. It is necessary to inspect the lesion carefully and to make certain that the tissue is representative of the tumor itself and not just of the peripheral "inflammatory zone." In many cases granulations are produced in the vicinity of the lesion, and, of course, tissue removed from these will not show the growth. Bronchiogenic tumors must be graded with caution. In the study of biopsy material from bronchiogenic tumors, the fragment is by necessity small and often represents only a minor part of the tumor. It has been the authors' experience that several specimens taken at various intervals have shown

Fig. 9. Case 4. X-ray (lateral) showed opacity in the hilus area prior to lung collapse.

different degrees of malignancy, this being determined by the cytologic structure. It has been their practice to correlate the information obtained by bronchoscopy, roentgenography, and microscopic study of biopsy material. The sum of these three indicates the course to be pursued. Biopsy distinguishes inflammation and benign and malignant growths. Roentgenography and bronchoscopy guide the treatment.

Bronchography.—Opaque mixture injection has been helpful in showing failure of penetration into the tumor mass, and should become more popular.

Direct Diagnostic Aspiration.—In selected cases this has proven of positive biopsy value, but the central hilar lesions are not as a rule accessible for this method.

Gradually Increasing Selective Pneumothorax.—This method, suggested to us by Pol Corrylos (19), is of more recent origin. It has helped us to delineate the lesion more clearly, and is often a preliminary step to future operative interference in lessening the surgical shock. It is interesting to note that in the last several cases in which it has been instituted, it gave the patient clinical relief of the pulmonary symptoms, such as cough, expectoration, and pain. We must, therefore, regard it not only as a diagnostic or pre-operative step but also as a clinical therapeutic adjuvant.

THERAPY

Therapy of the cancer patient, relative to the general welfare and attention to the special symptoms, was instituted and individualized. At present, we are enthusiastic about the gradually increasing selective pneumothorax for the temporary alleviation of many of the chest symptoms. The following case report is also interesting apropos of alcohol therapy (20): in an almost moribund patient, with a clinical and radiologic diagnosis of carcinoma of the lung, daily injections of 10 c.c. of 20 per cent alcohol were given intravenously. The stimulating effect was astonishing and immediate, so that the patient was soon able to be up and about. The ultimate course of the disease was not affected. The authors suggest this treatment in any seriously weakened patient.

The two outstanding procedures are surgery and radiation therapy, singly or together. Baum (21), in a case report on radiation therapy in carcinoma of the bronchus, summarizes the general agreement among all authors on therapy in the recent literature as follows:

"(1) The great majority of authors recommend surgery as the only possible means of treatment, although very few of them hold out any hope of surgical cure, or even relief, and those who report surgical cases admit a mortality never less than 50 per cent and frequently much higher.

"(2) Most authors mention radiation therapy only to condemn it, but in three articles (Leddy and Vinson, Roberts, and Kernan), radiation is recommended and case reports of its favorable use are included."

Baum's conclusions are noted in part as follows:

"Leddy and Vinson report 10 patients who, after having received roentgen therapy alone, are living and well from fifteen months to

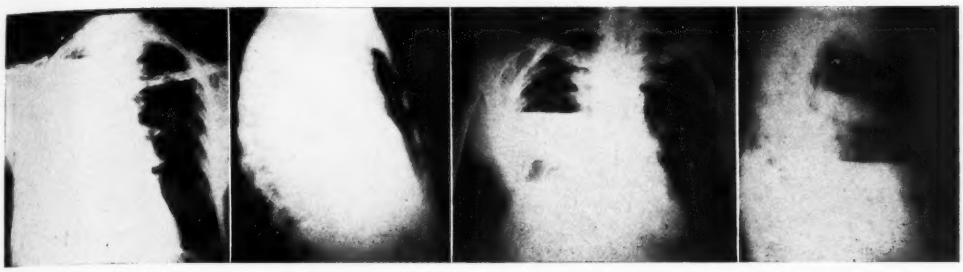

Fig. 10. Fig. 11. Fig. 12. Fig. 13.

Fig. 10. Case 5. X-ray (postero-anterior) showed massive collapse of the right lung with slight mediastinal deviation to the right.

Fig. 11. Case 5. X-ray (lateral) showed massive collapse of the right lung with clear substernal space.

Fig. 12. Case 6. X-ray (postero-anterior) showed right hydropneumothorax with localized area of encapsulated fluid.

Fig. 13. Case 6. X-ray (lateral). See Figure 12.

four years after the diagnosis. Kernan reports four patients without any evidence of carcinoma, two of whom are clinically well but show some remains of the lung tumor roentgenographically. As these represented 25 per cent of the first series and 66 per cent of the second, these results are certainly equal to those of surgery.

"There would seem to be justification for the conclusion that irradiation is to be preferred in the treatment of lung carcinoma, as it offers greater possibility of cure in the early cases, for the following two reasons: (1) the indications for its use are much less restricted than those of surgery; (2) in advanced cases beyond hope of cure by any means, it affords a far greater degree of palliation than can be otherwise obtained."

In the circumscribed lobar type, surgery may be the ideal method, if the operative mortality rate can be brought down. These cases comprise only about 25 per cent of the total number of lung cancers. Rabin and Neuhof (15) cite five operative cases, four of which died in one year and the fifth returned after one year with symptoms suggestive of cerebral metastases.

In the treatment of the non-circumscribed hilar type, with a tendency to early metastasis, comprising about 75 per cent of the total number of lung cancers, surgery is not very likely to find a place. The diagnosis can never be made early enough. Bronchoscopic removal may in the rare instance be possible. However, most of the cases must be treated by radiation therapy. G. Herrnheiser (22) reports 16 cases treated with deep x-ray therapy since 1931, with five still alive at the time of the report. He uses fractional protracted therapy from 300 to 400 r per field per sitting, and a total surface dose of 9,000 r.

The newer therapeutic technic of Coutard, suggested to us by Ira I. Kaplan (23), as applied to the lung may very well overcome our therapeutic failures of the past.

Ormerod (24) has treated patients by radon seeds intrabronchially, and some have survived from two to three and one-half years without recurrence.

PROGNOSIS

Although a few good results are quoted above, and we have higher hopes in the future from better surgical and radiotherapeutic technic, at present the outlook is gloomy, fatality being the rule rather than the exception.

CASE REPORTS

Case 1. C. K., No. 8,932, admitted from Bellevue Hospital on March 14, 1932, was a German counterman, aged 48 years. The patient's mother had died of cancer of the cervix at the age of 63. The patient gave a history of tumor in the right submaxillary area of four and one-half months' duration. A mass, 5 × 6 in., fixed and hard, was found in the right maxillary area, extending to the mastoid.

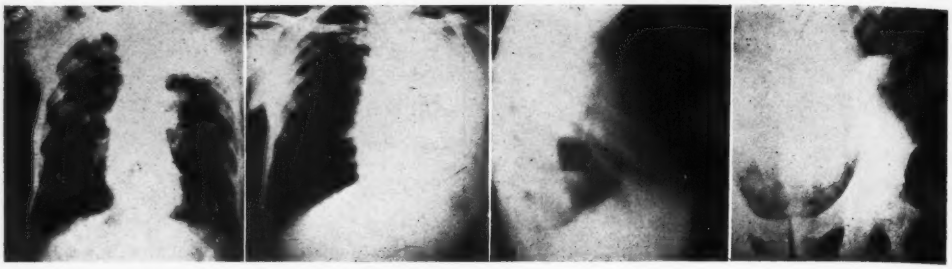

Fig. 14. Fig. 15. Fig. 16. Fig. 17.

Fig. 14. Case 7. X-ray (postero-anterior) showed opacity in the left apex with rib destruction and lung metastases.

Fig. 15. Case 8. X-ray (postero-anterior) showed massive collapse of the left lung with deviation of mediastinum to the left.

Fig. 16. Case 8. X-ray (lateral) showed pathology in middle third posteriorly.

Fig. 17. Case 9. X-ray of right hip and pelvis, showed destruction of iliac bone.

A biopsy taken from the mass revealed an epithelioma of bronchiogenic origin. X-ray examination of the chest was negative.

Therapy.—X-ray therapy of 1,200 r units had been given at Bellevue Hospital.

The patient died on April 24, 1932.

Autopsy.—The autopsy revealed a bronchiogenic cancer in the left main bronchus with metastases to the right of the neck. Around the left main bronchus at the hilus is a hard, grayish-white mass, about two centimeters in diameter, which is continuous with the bronchial wall.

Comment.—No clinical signs were noted from the lung; it was a silent primary malignancy.

Case 2. W. G., No. 2,413, admitted to the Central Neurological Hospital on June 6, 1930, was a musician, aged 66 years.

History.—The patient's history showed loss of appetite for three months, with a weight loss of 20 pounds; weakness, palpitation of the heart, and diarrhea. His father had died of cancer at 72 years of age.

Physical Examination.—Physical examination revealed that the pupil of the patient's right eye was smaller than that of the left. He had an occasional brassy cough and breath sounds, diminished at the bases. Fremitus was diminished at the left base; this area also showed flatness. Heart sounds were distant and muffled. The liver was one finger-breadth below the costal margin. Friction rub had developed over the left base.

X-ray Examination.—The heart deviated toward the left, with opacity at the left base, suggesting plastic basal pleurisy and adhesive mediastinitis.

Chest Aspiration.—A straw-colored fluid was present on aspiration.

The patient died on Aug. 20, 1930.

Autopsy.—The autopsy, performed by Dr. Vera Dolgopol, showed a squamous-cell carcinoma of papillary type in the left lower bronchus, which partially obstructed the bronchus and extended into the lung. An examination of the deeper layers disclosed a plexiform cancer and there were metastases in the adjacent bronchial lymph nodes, associated with bronchopneumonia.

Comment.—The cardiac symptoms overshadowed and masked the lung cancer.

Case 3. H. N., No. 12,541, admitted on Nov. 5, 1934, from the Brooklyn Health Department Clinic, was a white male, furrier by occupation, aged 50 years.

History.—The patient had had a cough for one year, hemoptysis for six months, and pain in the back for three months.

Physical Examination.—There was dullness to the left of the heart, with suppressed breath sounds in the left hilus.

X-ray Examination.—There was circumscribed opacity in the left chest, centrally in plane with the vertebral column.

Thoracoscopy.—Thoracoscopy revealed

a tumor, suggesting extra-pulmonary origin.

Therapy.—Surgical excision on July 12, 1935, showed the tumor to be a squamous-cell epithelioma, about the size of a grapefruit. On section, a bronchus was seen to pierce it, proving it to be intrapulmonary in origin.

The patient died two days later, on July 14, 1935, from post-operative shock, despite the use of the oxygen tank, blood transfusion, and special nursing.

Comment.—This peripheral cancer resembled a benign cyst.

Case 4. J. F., No. 13,256, admitted from Fordham Hospital on May 21, 1935, was a male leather-worker, a native of Russia, 67 years of age.

History.—The patient gave a history of two months' dyspnea, and a cough which produced blood-stained sputum. There was precordial pain, weakness, and loss of eight pounds in weight.

Physical Examination.—In the left supraclavicular region there was a stony hard mass and the left chest was flat. There was an absence of fremitus and breath sounds. The heart was retracted to the left.

X-ray Examination.—The x-ray examination revealed opacity of the entire left chest and a paradoxical movement of the left phrenic dome and deviation of the mediastinum to the left. There was obstruction in the left main bronchus.

Chest Aspiration.—There were no indications of tumor cells.

Bronchoscopy.—In the left main bronchus was seen a fungating, grayish-red tumor which bled freely upon manipulation and occluded the entire bronchus.

Biopsy.—A biopsy from the bronchus showed areas of epidermoid cancer of the spindle-cell type, distinct from the accompanying active fibroblastic reaction of a reparative character.

The patient died on Sept. 25, 1935.

Comment.—The respiratory paradoxical movement of the left phrenic dome during fluoroscopy proved to be especially interesting.

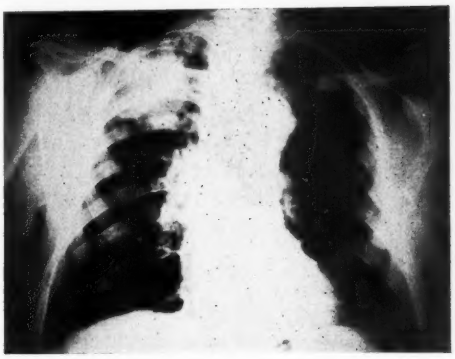

Fig. 18. Case 9. X-ray (postero-anterior) showed opacity in the right upper lobe (silent primary).

Case 5. C. G., No. 12,600, admitted from the Kings County Hospital on Nov. 22, 1934, was an American, aged 60. By occupation he was a checker at the docks.

History.—The patient gave a history of a "cold in the chest" which dated from a hernia operation in July, 1934. He also complained of a non-productive cough of four months' duration and of shortness of breath of three weeks' duration. There was no hemoptysis.

Physical Examination.—The pupils were dilated and the left was larger than the right. "Cogwheel respiration" was present; there was lagging in the right chest on respiration, and dullness in the entire right anterior and posterior chest. There was diminished tactile fremitus at the right base; breath sounds were bronchovesicular anteriorly and tubular posteriorly.

X-ray Examination.—Opacity of the right hemithorax was shown, and retraction of the heart and trachea to the right posteriorly.

Chest Aspiration.—There were blood elements and no tumor cells.

The patient died on Dec. 5, 1934.

Autopsy.—The autopsy revealed that a lung tumor occluded the right main bronchus and projected into the right auricle, with metastases over the heart.

Comment.—The metastases to the heart are of special interest.

Case 6. S. P., No. 13,329, admitted to

the hospital on July 17, 1935, was an Italian male, aged 50 years.

History.—The patient experienced a sudden onset of illness in October, 1934, with a cough and foul-smelling expectoration of about one ounce daily. A phrenicectomy and a pneumothorax were followed by a right lower lobe lobectomy by Dr. Coryllos.

Physical Examination.—There was a biopsy scar in the right supraclavicular area, and an old thoracectomy wound at the angle of the right scapula was draining pus. There was lagging in the right chest. Hyperresonance was present except at the base, where dullness and absence of breath sounds occurred. The patient had clubbed fingers.

X-ray Examination.—The x-ray revealed a right hydropneumothorax with a localized area of encapsulated fluid, and calcified pleura inferiorly.

Biopsy.—A biopsy (at St. John's Hospital) from the supraclavicular area was negative.

Bronchoscopy.—A bronchoscopy (at the Metropolitan Hospital) showed an epidermoid carcinoma of the right bronchus.

X-ray Therapy.—The patient was given 1,800 r units.

Comment.—There were post-operative complications which resulted in the death of the patient on Aug. 11, 1935.

Case 7. G. B., No. 12,421, admitted from Kings County and Greenpoint Hospitals on Oct. 30, 1934, was an unemployed male German, aged 62 years.

History.—He gave a history of pain in the shoulders, elbows, and anterior right ribs. These pains had been continuous for eight months. The condition was accompanied by loss of weight.

Physical Examination.—The patient's right pupil was larger than the left, and the trachea was deviated to the right. There were two small nodes posteriorly on the border of the left sternomastoid. The chest was markedly asymmetrical, the left side being smaller than the right. There was dullness posteriorly and in the left apex. Breath sounds were greatly diminished in the left chest.

X-ray Examination.—There was a dense shadow in the left apex above the fifth rib, posteriorly, and in the rest of both the left and right lungs were nodular metastases. There was complete destruction of the left first rib, the outer end of the clavicle, the glenoid fossa, the right anterior iliac crest, and the neck of the right scapula. There were numerous old fractures of the ribs bilaterally, and curvature of the midthoracic spine.

Biopsy.—A biopsy of a left supraclavicular node showed a transitional cell type metastatic cancer from the lung.

The patient died on Nov. 19, 1934.

Autopsy.—There was a bronchiogenic cancer in the left upper lobe of the lung, with metastases to the rest of the left and to the right lung, second rib, liver, kidneys, right adrenal, skin, and retroperitoneal nodes.

Comment.—The lung metastases are of interest.

Case 8. J. K., No. 8,503, admitted on Nov. 17, 1931, was an Austrian cabinet maker, aged 40 years.

History.—He gave a history of a cough of one year's duration, blood-stained sputum, and a continuous pain in the left upper chest. He had lost 25 pounds in weight.

Physical Examination.—There was flatness of the left chest posteriorly and in the axillary region. Breath sounds were absent. There were râles and a diminished vocal fremitus. The patient's fingers and toes were clubbed.

X-ray Examination.—There was opacity in the left chest from the second rib to the base in the middle third on the lateral view. There was bronchiectasis and a productive tuberculosis above it. The mediastinum showed deviation to the left.

Bronchoscopy.—There was a tumor of the left bronchus.

X-ray Therapy.—The patient was given 5,000 r between November, 1931, and March, 1932.

He died on May 18, 1932.

Autopsy.—The autopsy revealed a bronchiogenic cancer of the left lung with metastases to the liver and adrenals.

Comment.—The metastases to the adrenals are of interest.

Case 9. C. C., No. 12,623, admitted on Nov. 28, 1934, was an Italian saloon-keeper, aged 60 years.

History.—The patient gave a history of six months' pain and an increasing swelling over the right hip.

Biopsy.—A biopsy (in the Central Neurological Hospital) showed a metastatic squamous-cell epithelioma.

Physical Examination.—Over the back of the right hip was an open, five-inch incision of recent origin. There was a large node in the right groin. The liver was palpable. Chest examination showed shallow excursion, a dull right apex with accentuated breath sounds. There were râles in the left chest.

X-ray Examination.—Opacity was localized in the right upper lobe between the first and third ribs.

X-ray Therapy.—This consisted of 1,200 r between Dec. 10, 1934, and Dec. 26, 1934.

The patient died on Jan. 9, 1935.

Autopsy.—There was a carcinoma of the right upper lobe with metastases to the ribs and ilium.

Comment.—The primary lung cancer was silent, the symptoms originating from the hip metastasis.

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INTRATHORACIC TUMORS; THEIR DIAGNOSIS AND TREATMENT[1]

By SAMUEL BROWN, M.D., *and* J. E. McCARTHY, M.D., *Cincinnati, Ohio*

NO new principles have been evolved in the diagnosis and treatment of intrathoracic tumors, but the writers desire to report several cases which have been under observation, possessing as they do some special features which may be of interest to radiologists.

In the roentgenologic examination of the chest for a possible newgrowth the following plan was followed:

(1) *The demonstration of an abnormal shadow in the thoracic cavity.* Within the visible part of the lung-field in the usual anteroposterior view, any abnormal shadow is readily recognized, but if located in the mediastinum, it may be entirely obscured by the heart and great vessels. To establish its presence with certainty the usual anteroposterior view must be supplemented by a lateral one.

(2) *The localization of the abnormal shadow.* For exact localization of this shadow, we have found that the true anteroposterior and lateral views are the most useful positions. Stereoscopic examination of the chest in the anteroposterior position gives little information as to location, and none if the shadow is obscured by the heart and great vessels.

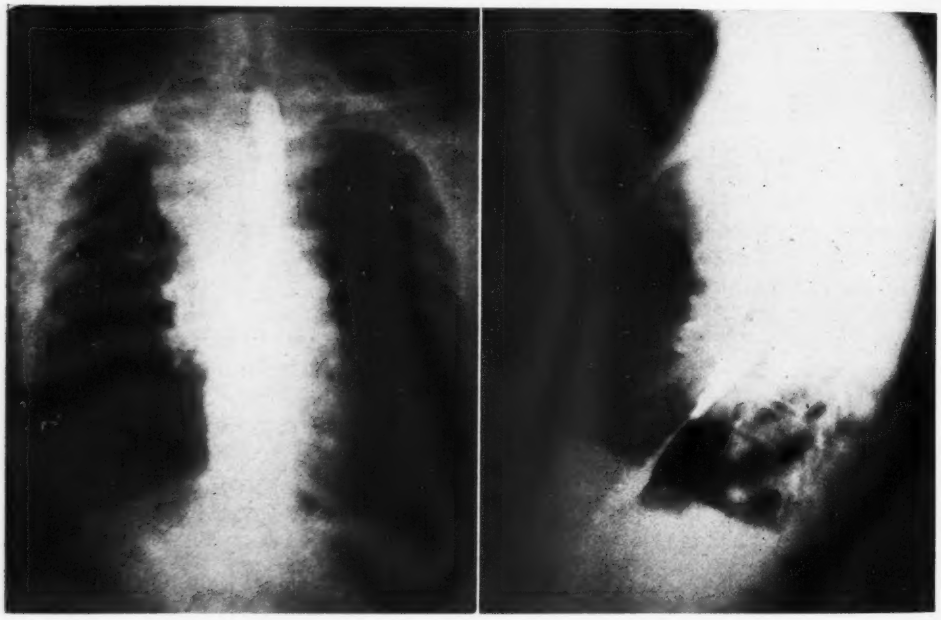

Fig. 1-*A*. Fig. 1-*B*.

Fig. 1-*A*. Oval-shaped dense shadow in the superior mediastinum located to the right of mid-spinal line. Esophagus and trachea are displaced to the left. Hilar glands are enlarged (anterior view).
Fig. 1-*B*. The tumor is located anteriorly. On postmortem examination the tumor was proven to be due to a malignant endothelioma with hilar metastasis (lateral view).

(3) *The origin of the abnormal shadow.* Its location having been settled, its origin must be determined if possible. This is generally accomplished by the study of the abnormal shadow in relation to the surrounding structures from every possible angle. If this method is unsuccessful, other means are resorted to, such as the

[1] Presented before the Radiological Society of North America, at the Twenty-first Annual Meeting, in Detroit, Dec. 2-6, 1935.

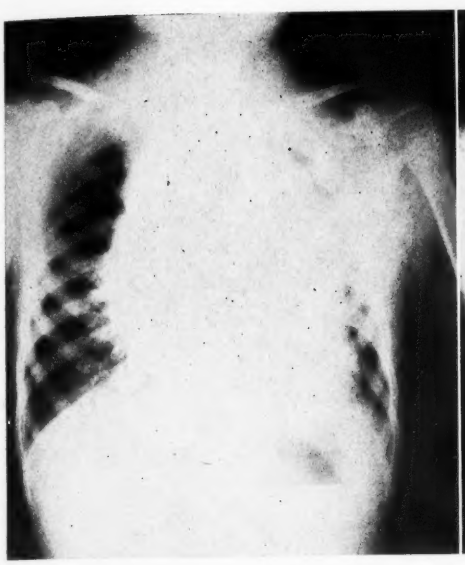

Fig. 2-*A*. Large anterior mediastinal tumor in a boy, aged seven years.

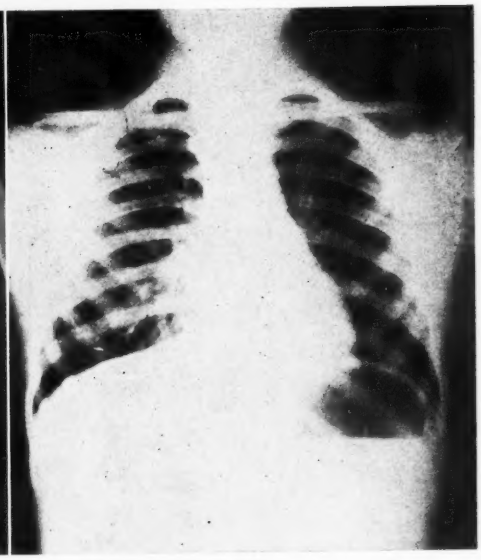

Fig. 2-*B*. The mediastinal tumor is entirely retrogressed after x-ray treatment.

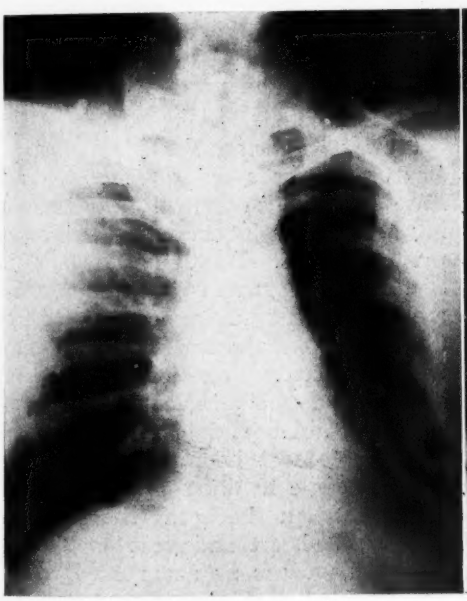

Fig. 3-*A*. No abnormal shadows are noted in the chest (anterior view).

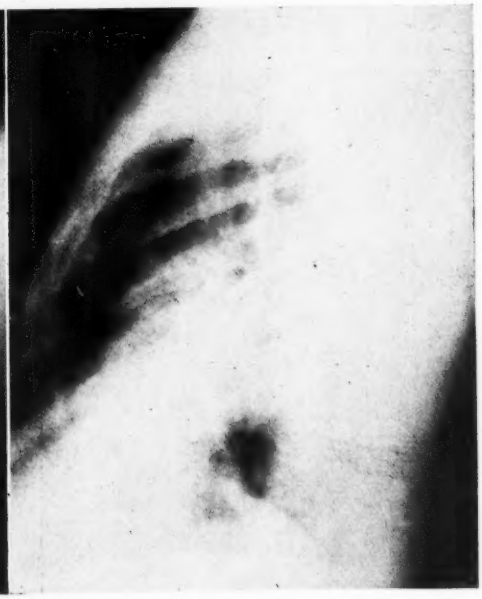

Fig. 3-*B*. A dense shadow is noted behind the heart obscuring almost the entire retrocardiac space (lateral view).

induction of artificial pneumothorax, or the introduction of an opaque medium into the tracheo-bronchial tree, or the evacuation of pleuritic fluid, which, when present, is apt to obscure entirely the abnormal shadow. Mention should be made of the bronchoscope which has proved to be of great value in not only

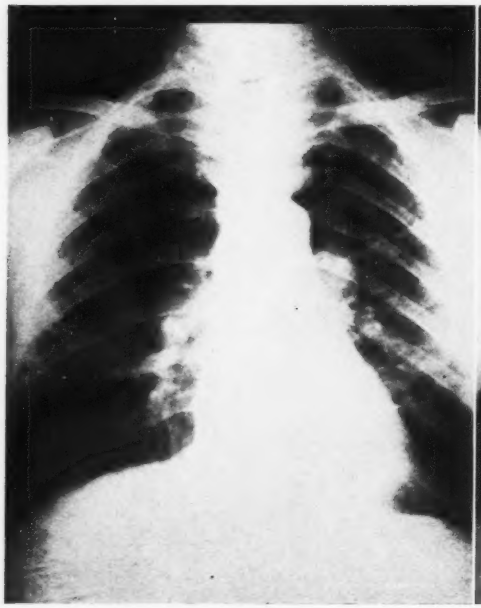

Fig. 4-*A*. A dense shadow is noted in the left hilar region (February, 1935).

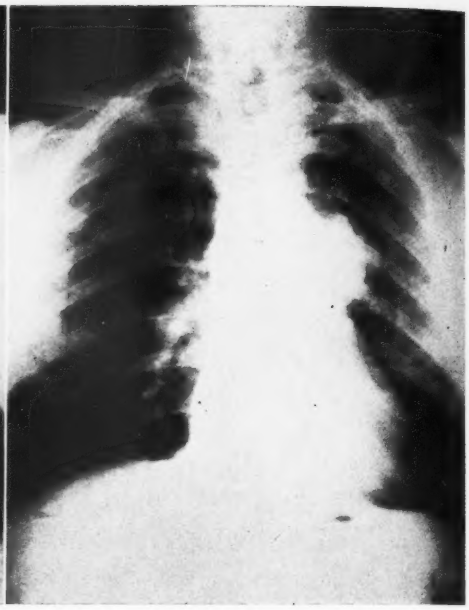

Fig. 4-*B*. The tumor in the left hilar region is greatly increased (October, 1935).

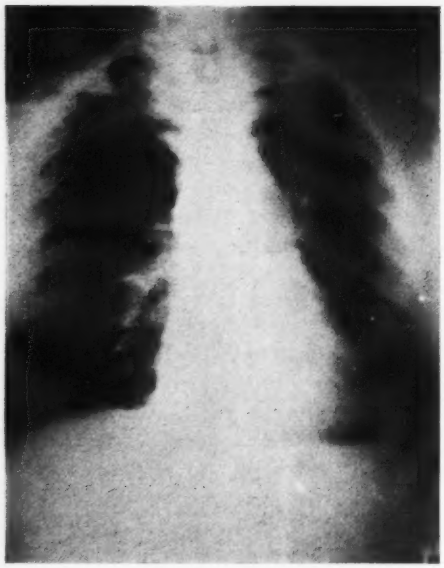

Fig. 4-*C*. The tumor shows marked retrogression two weeks after the last x-ray treatment.

determining the origin of the abnormal shadow, but enabling one to obtain a specimen for microscopic examination and the application of local treatment, if such is indicated.

(4) *Is the abnormal shadow inflammatory or neoplastic in origin?* As a rule, little difficulty is met with in differentiating between an inflammatory and a neoplastic process. However, in the region of the mediastinum in which aneurysms are of frequent occurrence, the differentiation between the two processes is often quite difficult. Pulsations of the expansile type usually indicate an aneurysm; however, absence does not exclude it. The chest must be studied from every possible angle in order to determine the exact relation between the abnormal shadow, the heart, and great blood vessels. If the shadow is an aneurysm it cannot be separated from the aorta, but if neoplastic it may be dissociated from the latter. The ofttimes observed extensive destructive changes in the ribs, sternum, and spine indicate the aneurysmal character of the mass, for neoplasms seldom cause much bony change. Finally, one must take full cognizance of the clinical

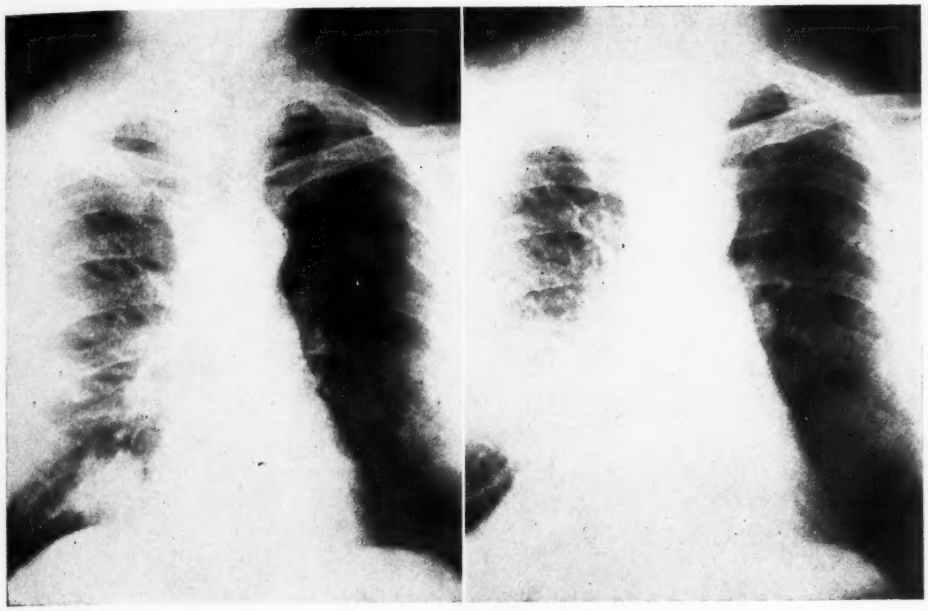

Fig. 5-*A*. Circular dense shadow at the base of the right lung.

Fig. 5-*B*. Marked extension of the tumor one and a half years later.

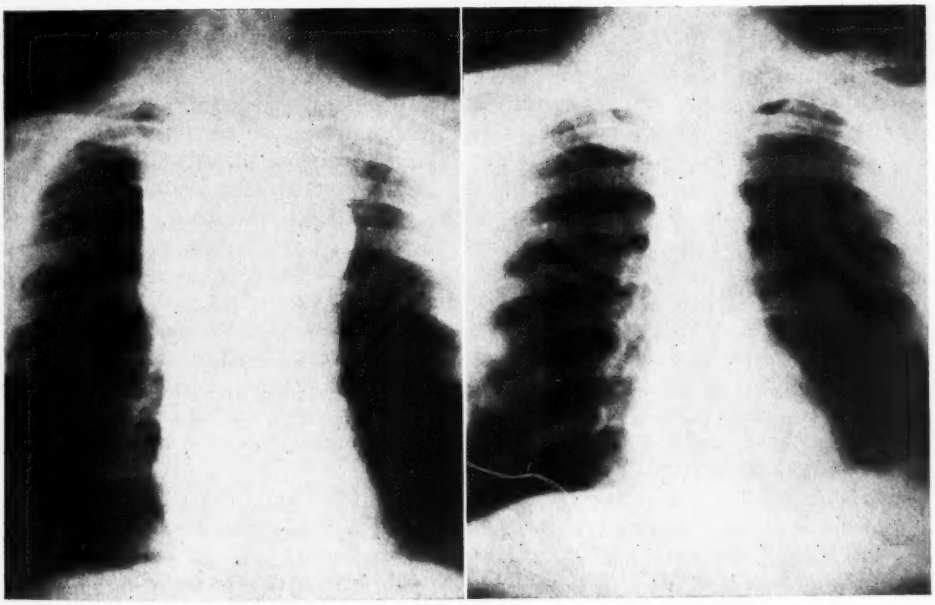

Fig. 6-*A*.

Fig. 6-*B*.

Fig. 6-*A*. Large superior and anterior mediastinal tumors due to metastasis; primary in the testicle.
Fig. 6-*B*. Complete retrogression of the metastatic tumor two weeks later, under x-ray treatment.

history, which may shed considerable light upon the nature of the tumor.

(5) *Is the neoplasm benign or malignant?* It is often difficult to determine roentgenologically whether the tumor is benign or malignant. It has been our experience

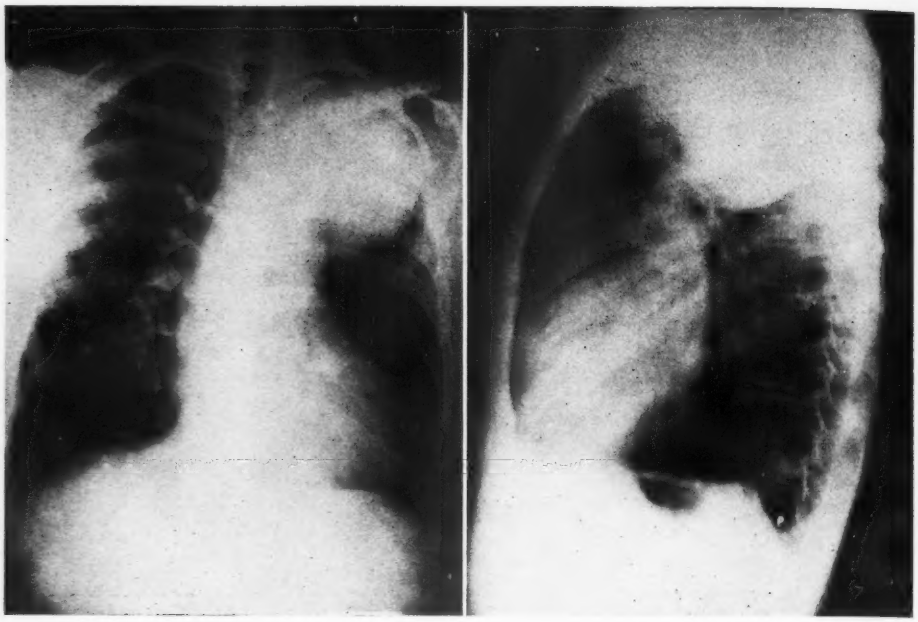

Fig. 7-*A*. Fig. 7-*B*.

Fig. 7-*A*. Large circular dense shadow in the upper region of the left lung (anterior view).
Fig. 7-*B*. The tumor is located posteriorly and was proven to be due to a neurofibroma (lateral view).

that tumors in the superior mediastinum are usually benign, while tumors elsewhere in the thoracic cavity are malignant. The x-ray therapeutic test is often of great help in this differentiation. Benign tumors never retrogress under the influence of x-ray treatment, while malignant tumors often do.

(6) *Is the malignant growth primary or secondary?* The presence of a solitary mass generally indicates a primary intrathoracic tumor, while multiple masses indicate metastases. A knowledge of a primary tumor elsewhere in the body makes it practically certain that the mass or masses in the lungs are secondary manifestations.

(7) *What is the exact nature of the tumor?* The roentgenologic method does not propose to make a microscopic interpretation of a tumor. However, experience of many years has taught roentgenologists to associate certain microscopic characteristics with tumors. This knowledge is based upon the degree of susceptibility of certain cells to roentgen or radium therapy. Thus, it is well known that lymphoid tissue tumors are the most radiosensitive of all. As regards malignant tumors, those which are cellular are quite radiosensitive, and as regards the cells, those which are immature, and which are in an active stage of division are the most susceptible to radiation.

Several cases have been chosen for a more or less detailed discussion. These cases are described according to the anatomic region of the thorax from which they are derived.

SUPERIOR MEDIASTINAL TUMORS

The superior mediastinal region is a very frequent site of tumor formation. Most of these newgrowths are benign and originate from the thyroid gland. As a rule, the roentgenologic diagnosis is not difficult. One readily notices the sharp outline of the oval-shaped shadow which frequently extends above the root of the neck and occasionally overlaps the arch

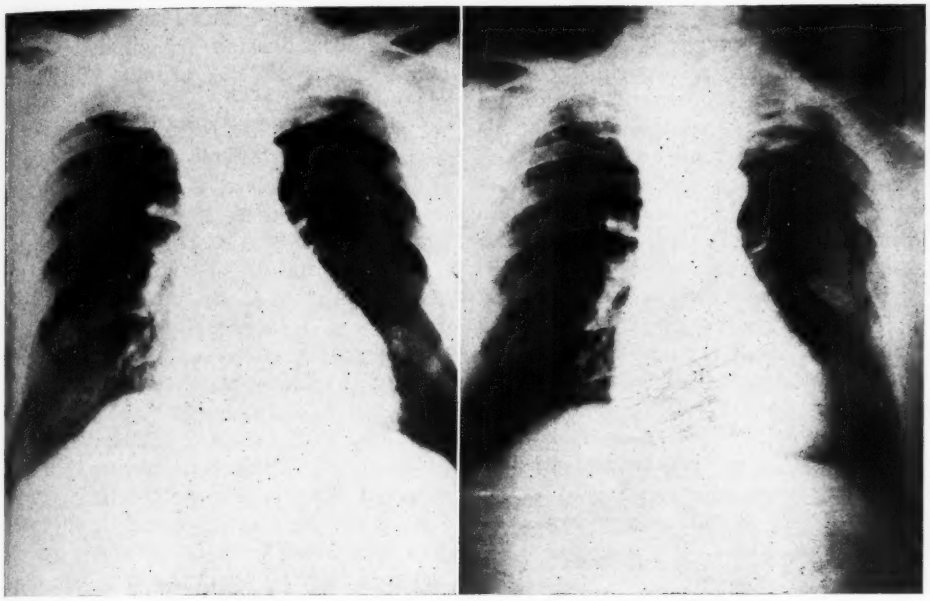

Fig. 8-*A*. Fig. 8-*B*.

Fig. 8-*A*. Superior mediastinal tumor located to the right of the mid-spinal line. Seventh rib on the left side shows an area of destruction.

Fig. 8-*B*. Roentgenogram taken one year later. The superior mediastinal tumor is the same. A dense shadow is noted in the region of the seventh rib on the left side. This was proven to be due to metastatic thyrogenic adenocarcinoma.

of the aorta. The trachea and esophagus are usually displaced to the right. When the tumor is located unilaterally, which is commonly on the right side of the spine and below the root of the neck, the diagnosis is rendered somewhat more complicated. This is due to the fact that aneurysms are frequently found in this location from which it is often difficult to differentiate. In the absence of expansile pulsations and abnormal changes in the bony skeleton and a negative clinical history of syphilis, one is justified in making a diagnosis of a newgrowth. Such an example is illustrated by the following case.

Case 1. Mr. A. M., aged 50 years, was referred for a roentgenologic examination because of cough and a sensation of pressure in the upper region of the chest. The roentgenograms taken both in the anteroposterior and lateral positions (Figs. 1-*A* and 1-*B*) revealed an oval-shaped mass in the region of the superior mediastinum to the right of the mid-spinal line. The hilar lymph nodes were found enlarged. The trachea and esophagus were displaced to the left. In the lateral position, the mass was located anteriorly, with the esophagus and trachea displaced backward. No abnormal changes were noted in the bones. Fluoroscopically, no expansile pulsations were recognizable. The heart and aorta appeared normal in position, shape, and size. The clinical findings were negative as to syphilis. In view of the above findings, the diagnosis of a malignant newgrowth was made. On postmortem examination, the tumor was proven to be due to a malignant endothelioma with hilar metastasis.

ANTERIOR MEDIASTINAL TUMORS

The anterior mediastinal region is probably the most frequent site of malignant newgrowths. These tumors usually originate from the lymphoid tissue and because of that are very radiosensitive. The following case is used as an illustration.

Case 2. A boy, aged seven years, had had an intermittent cough for several months, which failed to yield to treatment. Subsequently, edema of the face and neck were noted. A roentgenologic examination (Fig. 2-*A*) revealed a large mass in the anterior mediastinum. An improvement in his condition was noted twenty-four hours after the institution of roentgen therapy. Treatment lasted six days, at the end of which time he had received a total of 1,800 r units, given through four portals. The last examination was made twenty-two days after treatment was begun, and showed complete retrogression of the neoplasm (Fig. 2-*B*). The exact nature of the newgrowth is not known, but judging from the rapid rate of its retrogression, it probably originated from the thymus gland.

POSTERIOR MEDIASTINAL TUMORS

Tumors arising in the posterior mediastinum are readily recognized provided they extend beyond the heart shadow, but when limited in their extent they are often overlooked in the usual anteroposterior view. Such an example is illustrated by the following case.

Case 3. F. H., aged 43 years, complained of cough and bloody expectoration. Stereoscopic examination of the chest in the anterior position failed to reveal anything abnormal (Fig. 3-*A*). In the lateral view (Fig. 3-*B*) there was noted almost complete obliteration of the retrocardiac space by a dense shadow. The mass did not respond to roentgen therapy.

BRONCHIOGENIC TUMORS

Bronchiogenic tumors are relatively speaking of very common occurrence and are usually recognized late in the disease when secondary pulmonary changes have already taken place, thus confusing the picture. The following case is probably the earliest that has come under our observation.

Case 4. I. R., aged 60 years, complained of cough which occasionally was followed by bloody expectoration. He was referred elsewhere for a roentgenographic examination which revealed a dense shadow on the left side of the pulmonary artery (Fig. 4-*A*). This shadow was interpreted as a large lymph node and was regarded as of no special significance. Eight months later, the patient was referred to us for examination because the symptoms persisted and became gradually more pronounced. Roentgenologic study revealed a mass of considerable size (Fig. 4-*B*) located behind the trachea which was somewhat displaced forward and to the right. The great increase in the size of the mass and persistence of the clinical manifestations suggest that it is in all probability of malignant nature. He has received a course of roentgen therapy consisting of 6,000 r units, given through four portals. The bloody expectoration ceased shortly after the termination of the treatment. Three weeks later, he was reexamined and the roentgenogram (Fig. 4-*C*) shows marked retrogression of the tumor.

PULMONARY TUMORS

Pulmonary tumors like bronchiogenetic ones are usually far advanced when first discovered by the x-ray. It is only seldom that an early case of a pulmonary tumor is diagnosed. Such an example is illustrated by the following case.

Case 5. A. K., aged 45 years, was referred for a roentgenologic study of the chest because of cough and bloody expectoration. The roentgenogram revealed a circular dense shadow just above the right diaphragm close to the heart border (Fig. 5-*A*) and located behind the anterior chest wall. The diagnosis of a pulmonary tumor was made but, because of a difference of opinion on the part of the clinicians regarding the correctness of the diagnosis, no further action was taken. One and a half years later, he was again referred for an examination. The roentgenogram (Fig. 5-*B*) showed marked extension of the pulmonary lesion. Six months later, the entire lower lobe was found involved. Roentgen therapy was then begun without

any result. The patient lived for several months. A postmortem examination showed that the lesion was a carcinoma.

METASTATIC TUMORS

Pulmonary metastasis is a frequent finding and easily diagnosed, though when the metastasis consists of a solitary mass, it may be more difficult. The history of a primary lesion elsewhere in the body makes the diagnosis simpler.

Case 6. F. K., aged 35 years, was referred because of dyspnea, and edema of the neck and face. A roentgenogram (Fig. 6-*A*) revealed a mass in the superior anterior mediastinum which was considered to be of primary nature. Roentgen therapy was immediately begun and two weeks later a re-examination (Fig. 6-*B*) showed complete retrogression of the tumor. Several months passed and the patient returned with a mass in the abdomen. A further physical examination revealed a swollen testicle, thus explaining the nature of the primary growth, which was proven to be a teratoma testis. Metastases arising from teratoma testis have been found to be very sensitive to x-ray and several of our patients have lived for many years after treatment.

EXTRA-PULMONARY TUMORS

Extra-pulmonary tumors are not very common.

Case 7 is one of the most interesting cases in our experience. It is that of a young man, aged 16 years, who was recommended for an examination of the dorsal spine, whereupon a large tumor was discovered in the upper region of the left lung (Figs. 7-*A* and 7-*B*). X-ray treatment was begun, but the tumor did not retrogress. The opinion was then expressed that the tumor was of benign character. After several years of close observation, there was noted a slight increase in the size of the tumor, and it was decided to operate. The histologic section revealed a neurofibroma, thus explaining its failure to respond to treatment.

Case 8, another case of extra-pulmonary origin, is that of a male, aged 63 years, who was referred for examination because of pain in the chest and left lumbar region. A dense shadow was noted in the superior mediastinum on the right side of the spine. The seventh rib on the left side presented an area of bone destruction (Fig. 8-*A*). One year later, the patient returned for a re-examination of the chest (Fig. 8-*B*), which revealed the same findings in the superior mediastinum and, in addition, a dense mass in the region of the seventh rib on the left side. Roentgen therapy failed to exert any beneficial result, and the tumor was resected. Microscopic examination disclosed a metastatic thyrogenic adenocarcinoma. This finding would point to the probable malignant condition of the superior mediastinal mass which is likely of a thyroid origin.

CONCLUSION

The plan of roentgenologic study of the chest for possible newgrowths is described in more or less detail. Several cases have been chosen, each representing a certain region of the thoracic cavity, for special description. Many of the patients were treated with roentgen therapy and some of them showed a definite temporary improvement, those with mediastinal tumors reacting more favorably. The failure to obtain results of a more permanent nature is probably due to the fact that the great majority of the cases were in an advanced stage of the disease when first seen.

DISCUSSION OF SYMPOSIUM

DR. LAWRENCE REYNOLDS (Detroit): The importance of this subject needs no further emphasis if you have been listening attentively to the papers given this afternoon on carcinoma of the lung. Apparently this condition is definitely increasing. Why it is, no one knows.

It was in 1921, I believe at a meeting of the American Roentgen Ray Society in Minneapolis, that Dr. Johnston, of Pittsburgh, gave a paper on carcinoma of the lung in which he discussed nine cases. Many of the roentgenologists sitting in

the audience at that time had not a single case of their own in which they had made a diagnosis from the roentgen examination; consequently, they asked him upon what he based his diagnosis. He said, "If a patient comes to me in the carcinoma age and I examine the chest and find an atypical lesion and the patient tells me he has been coughing and has spit blood, I make first a diagnosis of carcinoma of the lung if it isn't an apparent tuberculosis, and I have been correct in six consecutive diagnoses."

That was in 1921.

Since that time many papers have appeared in the literature and you have heard at various meetings discussions of this important subject. Each man who discusses it reports increasing numbers of these cases; consequently, it is a disease of considerable importance to the roentgenologist; it is a disease in which all of us must have the co-operation of the various members of the profession; it is a disease which clinically, at first, is one of symptoms rather than signs, because the various speakers this afternoon have emphasized the importance of cough, of expectoration, of the spitting of blood.

That train of symptoms might be associated with most of the disease processes which attack the pulmonary system. Therefore, when a roentgenologist examines a film of the chest and finds an atypical lesion in a patient of carcinoma age, he must be, as Manges has so aptly pointed out, carcinoma-of-the-lung-minded, if he is to make any sort of early diagnoses on these patients in hope of cure.

In the past too many reports have dealt with the histogenesis and metastasis of these disease processes rather than points of diagnosis. Happily, this afternoon you have listened to a detailed description of points of diagnosis which all of you should carry away with you and remember and apply in your daily practice. A brilliant rôle which roentgenologists have played in the diagnosis of tuberculosis can and will be repeated in this particular disease process if we carry away with us the sort of information which has been conveyed through these papers given this afternoon.

The roentgen diagnosis is of tremendous importance but it must carry with it the additional assistance that can be given by the bronchoscopist and also by lung mapping with opaque oils.

Once a diagnosis has been made, what of the therapy of these cases?

Those of you who attended the American Congress of Radiology in Chicago will recall the pessimistic paper by Dr. Evarts Graham regarding carcinoma of the lung. It was his belief at that time that there was not a single authentic case of carcinoma of the lung well five years after its original diagnosis. He reported one case himself which he treated surgically, and I understand that case is well to-day, two or three years afterward.

However, other workers have reported different results, especially from roentgen and radium therapy, particularly Manges, Leddy and his associates, and Pancoast and Pendergrass.

If there is such a variance of opinion as regards the length of life following the original diagnosis in these cases under the present form of therapy as indicated by Graham, then there must be some difference of opinion among the pathologists as to exactly what is a primary bronchiogenic carcinoma, and it is to be regretted that Dr. Geschickter was not here this afternoon to add his knowledge to this splendid symposium. I personally want to express my very deep appreciation for the privilege of having heard this group of papers.

DR. W. E. ANSPACH (Chicago): Dr. Rigler has shown how fluids act when free in the pleural cavity. When fluids are not free in the pleural cavity, a different picture is produced on the roentgenogram. This is shown beautifully in a group of subphrenic abscesses in which the pleural cavity has been involved secondarily. Here there is first adhesive pleuritis which cements the base of the lung to the diaphragm. Following this, the exudate spreads upward about the lung frequently

presenting for a long period a shadow with a fairly well defined horizontal upper border. Occasionally later the fluid is sufficient in amount to resemble an emphysema with the exception that the base of the lung continues to contain air well out near the costophrenic sinus because the base is adherent to the diaphragm. These roentgenologic signs are especially significant in young children in instances in which frequently the clinical signs of subphrenic abscess are absent or so faint that they are thought to be referred because of the cough and other pulmonary symptoms. These roentgenologic signs are also significant because the gas and fluid level which in the past has been considered almost characteristic, is, in reality, seldom seen.

DR. RALPH E. MYERS (Oklahoma City): In Dr. Brown's valuable contribution to this symposium he called attention to a case of lymphosarcoma which proved so radioresistant that he was unable to accomplish much by treatment. As a general rule this tumor proves to be fairly radiosensitive, while adult squamous-cell carcinoma is usually quite the opposite. However, occasionally the converse is true, as is illustrated in part by Dr. Brown's case.

My purpose in calling attention to this is to point out the fallacy of trying to base treatment in any specific case on the so-called degree of malignancy as determined by the microscopic examination of the tumor. The location of the tumor ofttimes gives us a more accurate prognosis of what the effects of radiation will be than does the microscope. In case the tumor is located in a region ordinarily favorable for radiation treatment, the only way to determine its sensitivity with certainty is to watch its response to such therapy during the protracted treatment now in vogue.

One case Dr. Brown presented interested me especially because it closely parallels a case of mine. It was the case of a small growth, about the size of a silver dollar, a little above the diaphragm, which disappeared under treatment.

The patient of whom I am speaking came under my observation six and a half years ago. The growth was located a little above the right dome of the diaphragm and it, too, was about the size of a silver dollar. The patient complained of feeling a little below normal and of occasional coughing spells, sometimes accompanied by slight expectoration of blood. Following roentgen therapy of moderate intensity her health improved and the tumor shadow remained the same size for many months. I began to think I might have been dealing with the residuum from some old inflammatory process, and so became too optimistic in my advice to the patient. As a result I did not see her again for nearly two and a half years. When she returned the growth had more than doubled in size and her old symptoms had reappeared. There was now no doubt but that we were dealing with some type of malignant tumor. Following intensive roentgen therapy two and a half years ago the growth and symptoms entirely disappeared and the patient is perfectly well today. Except for a rather marked accentuation of the bronchovascular markings, the lower right lung now appears normal.

Lastly, I wish briefly to give the history of a case of carcinoma of the lung of which I feel very proud. My first contact with the patient was following the removal of a tumor, an extension of the lung tumor, from the left side of his back. It had destroyed about four inches of his fifth rib posteriorly. A film of his chest taken at another hospital five months previously showed a large tumor apparently confined to the upper half of the left lung and with the fifth rib at this time intact. Microscopic examination of the tumor revealed it to be a carcinoma whose structure presented the typical picture of what Dr. Geschickter, in a recent number of the "American Journal of Cancer," calls "carcinoma arising in the terminal bronchioles."

At the time therapy was instituted I was quite convinced that there was some chance of a cure if a protracted treatment

of sufficient intensity was given. My unusual optimism was based on some very gratifying results in another case, results which I realized later were to be explained by a different diagnosis. The treatment was applied for a period of seven weeks from five portals of entry. About three months after the conclusion of therapy he walked into my office, feeling very well and having gained at least 40 pounds in weight.

A few months later he began to have pain in his upper left chest, to run temperature, and gradually to lose weight. I disliked to give further intensive therapy, but finally concluded that a badly damaged skin might be compatible with a live patient. About a year after the first course of treatment, another intensive course was given. His symptoms once more disappeared and he resumed his gain in weight and strength. To-day, more than two years since his last treatment, he is still on the upgrade and has no symptoms of recurrence. The upper part of his left lung is a mass of fibrosis, the skin and subcutaneous tissues around the left shoulder are so badly damaged as to markedly restrict motion, but I have a very grateful patient and am beginning to have visions of a permanent cure.

After hearing what Dr. Brown said about treatment, I am wondering if he pushed his reactions to a sufficient intensity. Carcinoma of the lung is usually highly radioresistant. If we are to have any hope of a cure or even of good palliation, we must use very large doses and expect plenty of lung damage around the area treated.

My excuse for this rather long discussion is to point out that in this discouraging field of carcinoma of the lung, we may sometimes obtain good palliation by intensive roentgen therapy and perhaps occasionally attain a cure.

DR. JOHN T. FARRELL, JR. (closing): I would like to compliment Dr. Ehrlich on the way in which he has studied his cases and the minutiæ he has discussed so well. I believe that the observations based on our respective series are, for the most part, in agreement.

If I were understood to say that tumors of the bronchus are not usually of gradual onset, the impression should be corrected. Any disease in which 50 per cent of the patients are not seen within the first year of the appearance of the first symptom should certainly be considered of gradual onset.

Dr. Ehrlich and I have probably used different terms to describe the same roentgenologic changes. The change which I spoke of as atelectasis, Dr. Ehrlich probably has called density or tumor, while I have limited the term "tumor" to a circumscribed mass.

Dr. Myers spoke of the importance of ignoring the gradation of the tumor or type of malignancy in treatment. I, too, believe that cancer is cancer, and I quite agree with him that the important thing is vigorous x-ray treatment.

In discussing with Dr. Baxter L. Crawford, pathologist to the Jefferson Hospital, the pathologic findings of the cases which I have presented, Dr. Crawford pointed out that it is difficult to decide on the grade and on the histologic form of many of these tumors. The fact that in 24 cases, or 48 per cent, the diagnosis, even with microscopic section, had finally been carcinoma undifferentiated, would indicate that the pathologist has considerable difficulty in classifying and grading.

As Dr. Rigler pointed out, there are many other causes of bronchial occlusion other than carcinoma; but the fact remains that the most important single cause of bronchial occlusion in adults is bronchial carcinoma. Bronchial occlusion occurs in tuberculosis. It occurs as a result of nonspecific inflammatory change. We see it as a result of bronchial polyps, of benign adenomas or fibromas. I have known it to occur secondary to injury and secondary to bronchial metastasis; but the most common cause in adults is primary bronchial malignant neoplasm.

The final diagnosis of carcinoma in any location is made in one of two ways. Either one must have reliance on the opinion of

the pathologist who examines the tissue microscopically, or one must be convinced by the clinical course of the disease that the lesion is cancer.

In this particular instance I don't know quite wherein Dr. Rigler and I disagree or why there should be any disagreement, because roentgenographically I only make the diagnosis of bronchial occlusion, and in my report add, "I suspect the occlusion is neoplastic. The patient should be studied bronchoscopically." I don't think the bronchoscopist makes the diagnosis either, other than that the bronchoscopist removes a piece of tissue which, from his experience, he believes is neoplastic; he sends a specimen to the pathologist, who makes the tissue diagnosis of squamous-cell carcinoma, adenocarcinoma, or benign lesion.

I agree with Dr. Rigler that tumors which destroy ribs and produce bone involvement are probably more often pleural in origin than pulmonary; however, pleural tumors are much less common than pulmonary parenchymal tumors. It must also be remembered that some thoracic tumors are also primary in the ribs.

Dr. Brown made a remark to the effect that in mediastinal tumors bronchoscopy would be of doubtful value in deciding whether a given mediastinal mass, recognized roentgenologically, were benign or malignant. This is far from conclusions based on experience; and I can say this because I am not doing bronchoscopy. Often the bronchoscopist is able to detect evidences of malignancy on gross examination. The non-malignant mediastinal tumor does not produce fixation because it does not infiltrate. It acts in the same way as benign tumors in general, for instance, tumors of the breast—benign tumors of the breast—remain freely movable and do not become fixed—so also benign mediastinal tumors do not fix the adjacent tissues as malignant tumors do and this difference can be detected by the bronchoscopist.

DR. DAVID E. EHRLICH (closing): I would like to thank Dr. Farrell for really giving us the pleasure of a complete résumé of the clinical, x-ray, and pathologic study in much greater detail than I attempted. I am sure we do not disagree at all on the condition; in several of the instances, it is merely a matter of a few terms.

About the onset, that is really just a question of relativity when he said that in these cases it seems to have a more sudden origin as compared with mine. I would like to cite again very briefly two cases in which the primary malignancy was entirely silent.

Case 1 was a metastasis in a submaxillary area of four and a half months' duration. Autopsy a month subsequent to admission showed a primary carcinoma in the left upper lobe, which was not visible roentgenologically.

The second case was that of a man aged 66 years, who had pain and swelling over his left hip of about six months' duration. Biopsy showed a metastatic lesion, and we discovered the primary carcinoma in the right upper lobe with no pulmonary symptoms whatsoever.

One word more as to the surgeon; I hope there are not any here to throw me out! For the past several years, the surgeons have been claiming pre-eminence in the field. If you look over the statistics you will find that the operative mortality in malignancy is about 50 per cent or more, depending on the cases picked.

About two or three years ago, Rabin and Neuhof cited five cases upon whom they had operated. Four were dead within one year; the fifth one came back after one year with evidence of cerebral metastasis. I think our radiotherapeutic records will probably better that, especially if we can settle on this newer type of high voltage therapy. Of course, even the radiation therapists are expecting better surgical results as the surgical technical difficulties are surmounted.

THE INFLUENCE OF ROENTGEN THERAPY UPON THE BASAL METABOLISM IN LEUKEMIA

By WILLIAM S. MIDDLETON, M.D., OVID O. MEYER, M.D., *and* ERNST A. POHLE, M.D., PH.D., *Madison, Wisconsin*

From the Departments of Medicine and Radiology, University of Wisconsin

CERTAIN clinical features of leukemia led to an early study of the metabolism of patients with this condition. Minot and Means (1) drew a clear picture of the striking analogies between exophthalmic goiter and leukemia. The cardinal manifestations of increased heat production and of ravenous appetite with weight loss are common to both disease entities. The vasomotor instability and tachycardia of thyrotoxic states are remarked somewhat less regularly in afebrile cases of leukemia. Psychic disturbances are quite infrequent in leukemia. The eye signs of thyrotoxicosis are not duplicated in leukemia except in cases in which orbital infiltration occasionally leads to exophthalmos. Diarrhea and menstrual irregularities are less frequent symptoms in leukemia than in thyroid states. Myasthenia is usually more pronounced in thyrotoxicosis. Briard, McClintock, and Baldridge (1-*A*) remark upon the lack of clinical evidence for estimating the basal metabolic rate with any accuracy in patients with leukemia, whereas in patients with exophthalmic goiter, experience permits fairly accurate estimates.

The earliest study of the metabolism in leukemia is ascribed to Pettenkofer and Voit (2). Almost a quarter of a century elapsed before Bohland (3) and Kraus (4) made further independent studies upon this matter. With proper corrections, Magnus-Levy (5) felt that the figures of Pettenkofer and Voit (2) might be interpreted as establishing a higher gaseous exchange in their leukemic subject. Likewise, according to Meyer and Du Bois (6), a change in the base line in terms of modern calorimetry gives a distinct elevation to the figures of Bohland (3) and Kraus (4). Apparently, a full appreciation of the clinical significance of the metabolic changes in leukemia await the studies of Grafe (7). Since that time, many observers (8-20) have determined elevated basal metabolism in leukemia.

In explanation of this circumstance, the most fundamental studies relate to the metabolism of the leukocytes. Daland and Isaacs (21) found the oxygen consumption of the blood of a patient with myelocytic leukemia, and of one with a leukocytosis from sepsis, to be proportional to the number of adult neutrophiles. The oxygen consumption bore no relation to the total leukocytes, total immature leukocytes, erythrocytes, or hemoglobin. The rate of oxygen consumption was slow in immature cells as compared with the mature forms, a circumstance which placed the immature cells in Warburg's grouping of malignant tissue. Harrop and Barron (22), on the other hand, established no difference in the metabolism of mature and immature granulocytes. The respiratory activity of granulocytes from cases with leukocytosis and with myeloid leukemia did not differ; they found the glycolysis of neutrophiles to be five times greater than that of lymphocytes. In their studies, the Pasteur reaction of lymphocytes, representing the relation between respiration and fermentation, approximated that of normal tissue, whereas the reaction of the granulocytes was like that of tumor cells. In 1930, Glover, Daland, and Schmitz (23) reviewed the subject, and concluded that the metabolic activity of leukemic leukocytes varied directly with their maturity. Glycolysis bore an indirect relation to the maturity of the leukocytes. In contrast to Harrop and Barron (22), these workers found no difference in the glycolysis of cells of the same degree of maturity of the lymphoid and the

myeloid series, if due allowance was made for weight. The metabolism of normal neutrophiles was similar to that of the relatively mature leukemic cells of the myeloid group. Slight cellular injury profoundly influenced the oxygen consumption, but modified glycolysis to a lesser degree. They concluded that under aerobic conditions the sugar consumption of normal and mature myelogenous cells from leukemic patients resembled cancer tissue, while immature myelocytes, and mature and immature lymphocytes react as embryonic tissue. The recent work of Soffer and Wintrobe (24) reduced the above quoted differences to the overlooked factor of concentration; in their studies, the oxygen consumption of normal and leukemic blood was inversely proportional to the concentration. No appreciable differences existed in their results if due allowances were made for concentration. They found that the oxygen consumption of granulocytes exceeded that of lymphocytes, and concluded that the granulocytes resembled malignant tissue, and the lymphocytes, normal adult tissue.

Just as the laboratory workers in this field have not reached a consensus of opinion as to the cause of increased respiratory exchange in leukemia, clinicians are by no means agreed upon the answer. Bohland (3) early suggested that it probably depended upon the increased size of the spleen, liver, and lymph nodes. In his experience, the subject with the largest hepatic and splenic tumors showed the most intense increase in respiratory metabolism. Grafe (7) wrote: "Alle dies Tatsachen und Erwägungen lassen die Hypothese, dass die Stoffwechselsteigerung bei Leukämien durch das grosse Nahrungsbedürfnis der in grossen Mengen dauernd neugebildeten Leukocyten bedingt ist, nicht als zu gewagt erscheinen."[1] Gunderson (9) concluded: "The results of these observations indicate that the basal metabolism in myelogenous leukemia particularly bears a relation to the number of immature white cells in the blood stream, regardless of the total leukocytosis. The highest values for the basal metabolism are usually found in cases with very high counts and many myelocytes, or in cases showing high percentages of myeloblasts. Both of these findings probably signify great activity of the leukopoietic tissue, and the basal metabolism determinations may be considered as indices of this activity." Isaacs (25) remarked the increase of the basal metabolism and the uric acid in erythremia, leukemia, and pernicious anemia, in diversified states, with a common factor of a destruction of the nuclear materials of the blood elements. On this basis he suggested a possible relationship between the increased uric acid production and the elevated basal metabolism in patients with these conditions. Boothby and Sandiford (12) postulated "a hitherto unsuspected calorigenic agent of the catalytic type, possibly containing an amino group which increases metabolism in some such way as adrenalin and thyroxin." Du Bois (14) considered the possible existence of "some toxic agent which of itself affects metabolism"; but he also noted the increase in uric acid as evidence of high protein metabolism. In a very able discussion of the subject, Fortunato (18) rejected the causal relationship of splenomegaly, anemia, hyperleukocytosis, and immaturity of the leukocytes to this increased basal metabolism. Cellular hyperplasia in the hematopoietic centers did not explain the change to his satisfaction. He called attention to the parallelism between the basal metabolism and the amino acids in the blood, but did not grant a causal significance to the increase of the latter. Stüber (17) advanced the theory of an increase in the imperceptible loss of water to explain the elevated basal metabolism. Riddle and Stürgis (14) did not finally reject the theory of a relationship between the immaturity of the leukemic cells and the basal metabolic increase, but they admitted that increased destruction of the leukocytes might be a factor in the

[1] All these facts and considerations suggest as plausible the hypothesis that the increase in metabolism in leukemias is due to the increased demand for nutrition of the large number of newly formed leukocytes.

elevated metabolism in myelocytic leukemia. Baldridge and Barer (20) recently subjected the available evidence in this matter to a critical review. They concluded that the usual explanations were totally inadequate, and subscribed to the theory of increased protein catabolism as the most important single factor in elevating the basal metabolism of patients with leukemia.

Quite early in the development of this phase of the subject, Kraus (4) pointed out the fact that changes in the respiratory coefficient afforded a definite prognostic index. Grafe (7) noted a parallelism between the metabolic increase and the clinical course of the leukemia. Subsequent observers (1, 11, 13, 14, 16, 18, and 19) have repeatedly confirmed this point. Holboll (19) found that this correlation was not constant. Lennox and Means (11) significantly concluded that the basal metabo-

TABLE I. ANALYSIS OF CLINICAL AND LABORATORY DATA IN LEUKEMIC SUBJECTS AT THE HEIGHT OF BASAL METABOLIC ELEVATION

(*A*) *Acute Leukemia*

No.	Age	Sex	Duration Illness	T	P	Lymph Nodes	Spleen	Liver	% Hb.	Leukocytes	Immature	B.M.R.
55,988 (1)	16	M.	4 months	99	84	+	+	+	55	54,000	52,920	+48

(*B*) *Myelocytic Leukemia*

No.	Age	Sex	Duration Illness	T	P	Lymph Nodes	Spleen	Liver	% Hb.	Leukocytes	Immature	B.M.R.
37,514 (2)	32	F.	5 years	98	86	Submax.	+	+	45	258,000	159,900	+35
54,363 (3)	63	M.	2–3 years	98.6	70	Ant. cerv.	+	+	36	452,500	149,325	+53
12,804 (4)	64	M.	6 months	97.6	60	0	+	+	45	344,000	73,960	+36
9,782 (5)	51	F.	2 years	100	114	Cervical	+	+	18	185,000	116,550	+70.3
1,205 (6)	51	M.	7 months	99	76	0	+	0	60	370,000	59,200	+43.6
5,888 (7)	26	F.	26 months	99.6	114	+	+	+	25	640,000	176,000	+66.3
36,894 (8)	26	F.	13 months	98	78	0	+	+	50	332,000	126,160	+69
37,852 (9)	42	F.	4 years (?)	97.4	80	Cerv.; axl.	+	+	35	395,000	98,750	+56
4,694 (10)	35	M.	26 months	98.4	76	0	+	+	43	166,500	39,127	+66
66,193 (11)	39	F.	18 months	101.6	96	+	+	+	40	382,500	30,217	+98
51,569 (12)	40	F.	9 years (?)	97.4	60				70	34,850	4,530	+ 1
55,890 (13)	44	F.	3 years	98.8	86	Cervical	+	+	55	182,000	45,500	+56
67,234 (14)	52	M.	1 year	99.6	76	+	+	+	45	45,500	5,460	+64
66,991 (15)	50	M.	6 months	100.2	84	+	+	+	45	101,000	19,190	+43
57,306 (16)	40	F.	6 months	98.2	86	+	+	+	70	181,500	17,242	+28
66,352 (17)	37	F.	4 years	99.2	70	+	+	+	55	662,000	211,880	+75

(*C*) *Lymphocytic Leukemia*

No.	Age	Sex	Duration Illness	T	P	Lymph Nodes	Spleen	Liver	% Hb.	Leukocytes	% Lymphocytes	B.M.R.
57,767 (18)	26	M.	20 months				+	+	52	12,000	84	+14
61,658 (19)	54	M.	2 years	98	68	+	+	+	70	239,500	93.5	+35
51,742 (20)	59	F.	1 year	97.2	68	+	+	+	62	27,500	83	+39
51,790 (21)	52	F.	(?)	98.6	72	+	+	+	60	62,500	91	− 3
10,075 (22)	55	M.	10 years			+	+	0	73	63,250	94	+ 3
10,002 (23)	59	M.	1 year	97.6	66	+	+	0	78	12,970	66	+31
14,936 (24)	54	M.	18 months		90	+	0	+	85	13,200	71	+ 8
10,379 (25)	57	M.	14 months	98.6	62	Cervical	+	0	65	184,000	96.8	+48
12,931 (26)	53	M.	1 year	98	84	+	+	+	52	500,000	99.5	+47
2,640 (27)	54	F.	4 years	97.6	80	+	+	+	56	73,000	98	+54
53,653 (28)	29	M.	2 months	98	76	Cervical	+	+	70	40,900	61.5	+25
9,833 (29)	34	M.	(?)	98.6	84	Cervical	0	+	68	6,600	84	+18.2
11,877 (30)	45	M.	4 months	97	82	+	+	+	60	4,850	60	+27.9
68,308 (31)	58	M.	18 months	97	70	Axil.; inguin.	0	0	75	16,050	54	+38
62,949 (32)	47	M.	3 years	97.8	56	+	+	+	58	234,500	97	+58
68,477 (33)	59	F.	3 years (?)	98.2	72	+	+	+	58	185,000	85	+92
69,899 (34)	60	M.	3 months	97.2	76	+	0	+	70	42,400	89	+49
57,718 (35)	67	M.	(?)	98.2	68	+	+	+	70	47,100	78	+29

lism "seemed to be a truer indicator of the severity of the process than the leukocyte count." In chronic lymphocytic leukemia, Krantz and Riddle (16) extended the prognostic value of the basal metabolism determination thus: "(It) is to be correlated more closely with his (the patient's) symptoms, than is the height of the leukocyte count." In chronic myelocytic leukemia, Riddle and Sturgis (14) believed that "it gives an index of the activity of the disease, which is often difficult to obtain by any other single method of study."

The conspicuous response of the chronic leukemia to roentgen therapy affords a further basis for the study of the course of the basal metabolism under the changing conditions of the disease. Murphy, Means, and Aub (8) determined a slight fall in the basal metabolic rate of a patient with chronic lymphocytic leukemia under roentgen and radium therapy, coincident with the fall in the leukocytes. McAlpin and Sanger (13) determined declines in the basal metabolism of leukemic subjects paralleling the reduction of the leukocytes. These results have been amply confirmed, but Riddle and Sturgis (14) and Krantz and Riddle (16) remarked a transitory rise in the basal metabolism of short duration within 3 days after roentgen therapy. Isaac's (26) belief of a stimulatory effect of irradiation upon cells might perhaps be taken into consideration here.[2] This point takes on renewed interest and importance in the light of Baldridge and Barer's (20) explanation of the fundamental basis of the altered metabolism in leukemia. If protein catabolism be the important factor, certainly it would be speeded by roentgen therapy upon the destruction of the less mature nucleated cells. Musser and Edsall (27), Königer (28) and others have established this point beyond a question of doubt. By reason of the increased phosphorus metabolism, Musser and Edsall (24) concluded that roentgen therapy accelerated autolysis. In leukemic subjects under this treatment, they determined nitrogen excretion to be increased 70 per cent, uric acid 60 per cent, purin bases 260 per cent, and phosphates 200 per cent. Königer (28) felt that the increase in uric acid excretion, which paralleled the reduction in the size of the spleen, served as a definite measure of cell destruction. Furthermore, the time elapsing between such treatment and the transitory elevation in the basal metabolism lends strength to this explanation.

In spite of the overwhelming evidence of the prognostic value of basal metabolic determinations in leukemia and their application as a guide to roentgen therapy, this laboratory aid has not found a wide clinical acceptance. A review of the limited experience in the Wisconsin General Hospital was deemed justified in view of this circumstance. In Table I, these leukemic subjects have been grouped according to their types, and certain details relating to their clinical pictures and laboratory data have been listed for analysis. The stated basal metabolic rate represents the highest determination in each instance, and the cited clinical and laboratory details are of the same date.

Only five of the 35 leukemic subjects (Cases 12, 18, 21, 22, and 24) failed to show an elevation of the basal metabolic rate at the time of their study. Even this small minority might have been further reduced had the period of study in such instances been extended. It is interesting that one of these exceptions occurred among 16 cases of myelocytic leukemia, as contrasted to four among 18 cases of lymphocytic leukemia. In the single exception in the myelocytic leukemia group, Case 12, the relatively low total leukocyte count and total immature cells may be cited in extenuation. Case 14 most closely approximated Case 12 in these details, but the difference in the hemoglobin of these two patients was conspicuous (Case 12, 70 per cent; Case 14, 45 per cent). The basal metabolic rate was +1 per cent in Case 12, as compared to +64 per cent in Case 14.

[2] A careful study of the literature reveals the fact that no conclusive proof has been furnished so far that there is a true stimulative effect of radiation on cells.

Among the exceptions in the lymphocytic leukemia series, only Case 24 admits of an extenuating explanation. The relatively low total leukocyte count and lymphocyte percentage in this patient are both encountered in Case 23, in whom the basal metabolic rate was +31 per cent as compared with +8 per cent in Case 24. Case 21, on the other hand, presented a basal metabolic rate of −3 per cent, with levels of 62,500 leukocytes and 91 per cent lymphocytes. Such discrepancies cannot be reconciled to any known rules.

Passing to the other extreme, the highest basal metabolic rate determination among the myelocytic leukemia patients was +98 per cent in Case 11; the febrile rise was not an adequate explanation for this circumstance. Further, it cannot be ascribed to the degree of leukocytosis nor to the factor of immaturity, since both of these details are exceeded in a majority of the group (Cases 2, 3, 4, 5, 6, 7, 8, 9, 10, 13, and 17). In the lymphocytic leukemia group, the highest basal metabolic rate (+92 per cent) was recorded in Case 33. In this patient, no fever occurred to confuse the issue, and the total leukocyte count and the immaturity (as inferred from the percentage of lymphocytes) apparently bore no causal relation, in that either of both factors were exceeded in Cases 19, 21, 22, 25, 26, 27, 32, and 34.

The opportunity to follow the progress of leukemia patients under roentgen therapy by means of periodic or routine basal metabolic determinations was afforded in 21 instances (12 cases of myelocytic leukemia, and 9 cases of lymphocytic leukemia). The clinical and laboratory data upon these patients are collected in Table II. The case numbers are carried over from Table I (with the exception of acute leukemia). The column, "Roentgen Therapy" should be interpreted by means of the symbols in the key. Total doses applied during the entire treatment period are given. Treatment was not given at definite predetermined intervals, but only when the condition of the patient warranted it.

Careful analysis of the cases in Table II shows that there is but a rough parallelism between the basal metabolism and the leukocyte count, the percentage of immature cells, and the clinical condition of the patient. Though commonly subjective and objective improvement was coexistent with the lowered basal metabolism subsequent to irradiation, this was certainly not invariable. It will be noted that the parallelism seems closer in the cases of the lymphocytic leukemia group. It appeared that symptomatic improvement more closely approximated the diminution in metabolic rate than did the hematological findings, and this conforms to expectations based on clinical experience. Thus, though the metabolic rate bears a more than casual relationship to the patient's state of well being, it certainly is not an infallible guide. It furnishes but one of several indications as to whether or not irradiation is necessary at a certain time in a particular case. These results further emphasize the necessity for individualization of therapy, based upon the complete clinical picture in association with judgment resulting from a wide experience in this type of case.

However, an example of the close relationship between the basal metabolic rate and the leukocyte count and total number of immature cells is shown in Chart I. But even in this case, in the latter part of the course, the immature cells did not significantly increase, whereas the metabolic rate and total leukocyte count did.

In Chart II, there is represented a case of lymphocytic leukemia. This shows relatively little parallelism between the basal metabolic rate and the leukocyte count. Following early irradiation, there is actually an increase in the leukocyte count, perhaps suggesting a stimulatory effect upon the lymphocytic tissues, despite a concomitant diminution in the metabolic rate.

The technic of treatment was similar in all cases, but naturally the dosage as well as the site of irradiation was individualized.[3]

[3] All cases seen subsequent to Oct. 1, 1928, were treated by one of us (E. A. P.).

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TABLE II. RESPONSE O

No.	Age	Sex	Duration of Illness	Status before Therapy: Symptoms	Objective Signs	% Hb.	Leukocytes	Immature Cells
(2) 37,514	32	F.	5 yrs.	Aching and enlarg. abdomen; weakness: night sweats; wt. loss	Pallor; emac.; retinitis; S. L. and L. N.+	45	258,000	159,900
Readm. 3 mos. later				Well since disch.	S. smaller	68	17,250	0
Readm. 1 mo. later				Still in good shape		75	12,900	0
Readm. 2 mos. later				Dull ache (lower abdomen)	S. barely felt	70	14,400	144
Readm. 4 mos. later				Fair	S. slightly larger	60	23,950	1,197
Readm. 2 mos. later				Fullness in abdomen	S. larger	70	43,000	0
Repeated readmissions for therapy up to Readm. 25 mos. later				As above	S. and L. much larger	68	31,600	1,896
Readm. 1 mo. later				Nausea and vomiting, 2 weeks	S. larger	65	43,600	8,720
Last readm. 4 mos. later				Weakness	S. smaller	50	115,700	157
(3) 54,363	63	M.	2–3 years	Pain in lt. Hypochond. vertigo; nausea; warmth; wt. loss	Emaciation; S, L. and ant. cerv. L. N.+	36	452,500	149,325
Readm. 22 mos. later				Marked anorexia; pain increased	S. larger; pallor; fever	58	114,500	13,740
(4) 12,804	64	M.	6 mos.	Pain in lt. hypochond. epistaxis; fatigue; dyspnea	S. and L.+ pallor	45	344,000	73,960
Readm. 1 mo. later				Improved	No change	44	256,000	10,240
Readm. 23 days later				Marked improv.; resuming work	No change	53	28,000	0
Readm. 5 weeks later				Feeling well	Wt. gain; S. smaller	60	51,500	257
Readm. 3 weeks later				Working hard	No change	58	54,000	540
Readm. 1 mo. later				No change	No change	64	64,000	1,600
Readm. 5½ mos. later				Recurrence abd. distress after influenza 3 mos. ago	S. larger	48	286,500	51,570
Readm. 10 days later				Somewhat better	S. smaller	50	116,500	18,640
Readm. 2 weeks later				Better	S. smaller	65	127,500	11,475
Readm. 2 weeks later				Epistaxis, only	No change	55	38,500	2,117
Readm. 2 weeks later				No change	No change	55	18,500	370
Readm. 1 mo. later				No change	No change	58	26,700	0
Readm. 1 mo. later				Feeling well	S. smaller	74	42,400	0
Readm. 6 weeks later				Feeling fine	As above	55	51,500	1,545
Readm. 2 mos. later				Dull aching pain lt. hypochond.	S. larger	67	46,500	2,092
Readm. 2 mos. later				Pain as above	As above	45	39,500	1,580
Readm. 15 days later				Gas pains; referred pain to shoulder	Subcyanosis Abd. distension; râles			
(5) 9,782	51	F.	2 years	Mass in left hypochond. Nausea, vomiting; bleeding gums and nose; dyspnea; edema	Pallor; emaciation; cerv. L. N., S., and L.+	32	600,500	181,350
Readm. 3 mos. later				Anorexia; diarrhea; insomnia; nervous	S. larger; L. larger; basal râles; x-ray dermatitis	18	147,500	57,525
(7) 5,888	26	F.	26 mos.	Sore throat 3 mos. ago; choking; dyspnea; pain in left hypochond.; hemoptysis palpitation; edema;	Poor nutrition; pallor ecchymosis; L. N., S. and L.+	28	371,500	168,605

ONSE OF LEUKEMIC SUBJECTS TO ROENTGEN THERAPY

(*B*) *Myelocytic Leukemia*

	Imma-ture Cells	B. M. R.	Roentgen Therapy*	Supple-mental Therapy	Interval	Immediate Results: Symptoms	Objective Signs	% Hb.	Leuko-cytes	Imma-ture Cells	B. M. R.	Outcome
0	159,900	+35	S. (A. and P.) 3,050 r	Fowler's M iii t. i. d.	14 days	Gain 10 lbs. Gen'l improv.	S. smaller	66	12,000	120	+22	Early gain
0	0	+15	L. B. 1,875 r	None	4 days	Feels well						Gain held
0	0		L. N. (A. and P. M.) 800 r	None								Gain held
0	144	+28	L. 360 r in 3 years, 5 months	None								Gain held
0	1,197	+13	None	None								Gain held
0	0	+16		None		Sl. reaction to therapy		62	57,000	1,710		Lost ground
0	1,896	+24		None		No change			21,050	1,845		Further loss
0	8,720	+26		None	6 days	No change	S. larger	57	41,000	3,690		Failing
0	157			None								Failing (Died at home)
0	149,325	+53	S. (A. and P.) 2,200 r L. N. (A. and P. M.) 1,050 r	None	16 days				269,000	72,630	+29	Early gain
0	13,740		L. B. 1,000 r in 19 months		4 days	Steady slump			115,500	74,650		Died
0	73,960	+36	S. (A. and P.) 1,025 r	None	9 days			48	377,500	45,300	+22	Early gain
					8 days		S. smaller	40	288,000	18,720	+15	Further gain
0	10,240	+14.2	L. B. 750 r	None	7 days	Better but weak	S. receding		140,500	20,470	+13.9	Gain
0	0	+12	G. B. 100 r in 10 mos.	Bone marrow grs. V t. i. d.								Better
0	257	+16		Bone marrow continued								Improvement held
0	540	+23		Bone marrow continued								Still improved as above
0	1,600	+25		None								
0	51,570	+34	X-ray	None								Decline
0	18,640	+18		None								Gain
0	11,475	+13		None								Better
0	2,117	+ 6		None								As above
0	370	+ 7		None								As above
0	0	+10	None	None								As above
0	0	+ 7		None								Some improvement
0	1,545	+14		None								As Above
0	2,092	+20		None								Slump
0	1,580	+19		None	15 days 1 day			48	38,500	5,775		Worse Died
0	181,350	+52.6	X-ray	None	7 days				447,500	118,587	+48	
					7 days				316,500	102,862	+39.3	
					7 days				224,500	32,262	+36	
					7 days				145,000	19,575	+33.8	
					7 days				94,000	2,350	+58	
					7 days			40	49,500	1,237	+33	
					7 days				28,000	840	+34.3	
					7 days				22,950	2,179	+29.4	
					7 days				25,050	500	+38.8	
					7 days	Improved	S. smaller; wt. gain 16 lbs.		34,050	1,020	+26	Early gain
0	57,525	+70.3	None	None	7 days	Rapid decline			330,500	185,080		Died next day
0	168,605	+49	X-ray	None	8 weeks	Better	S. smaller		57,000	11,400		Early gain

(5) 9,782 51 F. 2 years	Mass in left hypochond. Nausea, vomiting; bleeding gums and nose; dyspnea; edema	Pallor; emaciation; cerv. L. N., S., and L.+	32	600,500	181,3
Readm. 3 mos. later	Anorexia; diarrhea; insomnia; nervous	S. larger; L. larger; basal râles; x-ray dermatitis	18	147,500	57,5
(7) 5,888 26 F. 26 mos.	Sore throat 3 mos. ago; choking; dyspnea; pain in left hypochond.; hemoptysis palpitation; edema; ecchymosis.	Poor nutrition; pallor ecchymosis; L. N., S. and L.+	28	371,500	168,6
Readm. 20 mos. later	Nausea; weakness, pain recurred (pregnancy in interval; hemorrhage 8 days postpartum); bleeding from gums; dyspnea	Pallor; cerv. L. N.+; tender thorax; distended abdomen; L.and S. larger; retinitis	25	640,000	176,0
(8) 36,894 26 F. 6 mos.	Swelling in abdomen; weakness (prior x-ray therapy)	Pallor; S. and L. enlarged; retinitis	46	611,000	274,9
Readm. 6 weeks later	One attack of abdom. pain	S. smaller	55	382,000	236,8
Readm. 5 weeks later	Abdominal soreness	Cheeks flushed; S. and L. larger	50	284,000	82,3
Readm. 5 mos. later	Feeling poorly 1 month; pain in upper abdomen, fatigue	Cerv. L. N.+; S. and L. larger	50	332,000	126,1
Readm. 1 mo. later	Weak; almost bedridden; headache	Abd. distend.; S. larger	50	184,500	75,6
(9) 37,852 42 F. 4 years?	Weakness; backache; anorexia; wt. loss	Emaciation; pallor; L. N., S. and L.+	35	395,000	98,7
Readm. 5 mos. later	Feeling well	S. smaller	60	331,000	59,5
(10) 4,694 35 M. 14 mos.	Fullness in abdomen; anorexia; wt. loss...	Abd. dist.; S. and L.+; pallor	42	210,000	46,2
Readm. 3½ mos. later	Fatigue; night sweats	S. larger	58	110,000	19,8
Readm. 11 mos. later	Weakness; pain rt. and lt. hypochond.; dyspnea	Orthopnea; Abd distend.; L. enlarged; S. larger L. N.+	44	117,000	21,0
Readm. 3½ mos. later	As above	As above	35	113,000	3,3
(13) 55,890 44 F. 3 years	Weakness; dyspnea palpitation; edema; night sweats	Cerv. L. N., L. and S.+	60	122,000	41,4
Readm. 2½ mos. later	First menstrual period in 6 mos.; stronger	S. smaller	55	31,750	3,8
Readm. 1½ mos. later	Anorexia; asthenia	S. larger	80	73,450	73
Readm. 1½ mos. later	Drawing sensation in side; easy fatigue; failing vision	No change in S.; ecchymosis	68	43,100	2,9
Readm. 1½ mos. later	Feeling well except for up. resp. infection	Râles at bases; L. and S. larger; petechiæ on palate	60	167,000	10,8
(15) 66,991 50 M. 6 mos.	Weakness; insomnia; dyspnea; anorexia (iron and liver)	Pallor; L. N., S. and L.+; retinal hemorrhages	30	161,500	

500	181,350	+52.6	X-ray	None	7 days				447,500	118,587	+48	
					7 days				316,500	102,862	+39.3	
					7 days				224,500	32,262	+36	
					7 days				145,000	19,575	+33.8	
					7 days				94,000	2,350	+58	
					7 days			40	49,500	1,237	+33	
					7 days				28,000	840	+34.3	
					7 days				22,950	2,179	+29.4	
					7 days				25,050	500	+38.8	
					7 days	Improved	S. smaller; wt. gain 16 lbs.		34,050	1,020	+26	Early gain
500	57,525	+70.3	None	None	7 days	Rapid decline			330,500	185,080		Died next day
500	168,605	+49	X-ray	None	8 weeks	Better	S. smaller		57,000	11,400		Early gain
000	176,000	+66.3	None	None					535,000	171,250		Died next day
000	274,950	+59	X-ray	None	10 days			45	600,000	270,000	+53	No improvement
					22 days			43	300,000	120,000		
000	236,840	+40		None	11 days			55	246,500	167,500	+41	
					5 days			60	285,000	91,200		Improved
000	82,360	+35		Iron	10 days			55	231,500	34,725		Gain
000	126,160	+69		None	5 days			44	206,500	49,560		Slump
500	75,645			None	14 days	Epistaxis; fever; cough		42	238,000	95,200		Further decline
000	98,750	+56	S. (A. and P.) 875 r	None	17 days	Color better, T. lower	S. smaller		152,000	12,160	+25	Definite gain
			L. B. 850 r		23 days				29,000	0	+13	Further gain
000	59,580		L. N. (A. and P. M.) 125 r in 5 mos.	None	45 days	Better	Wt. gain	60	127,000	38,100		Better
					19 days	Better	Improv.	55	82,500	25,575		Gain
000	46,200	+41.3		None	19 days			48	104,000	29,760		Early gain
000	19,800	+18	S. (A. and P.) 600 r in 2 mos.	None								No change
000	21,060	+52		None	9 days	More comfortable		43	166,500	39,127	+66	Some improv.
				Bone marrow; grs. V t. i. d.								
000	3,390			None	18 days			58	82,500	0		
000	41,480		S. (A. and P.) 1,200 r	Fowler's 8 days	10 days	No change	S. smaller	55	141,000	36,660	+40	No gain
			L. B. 650 r	Fowler's 5 days	5 days	Nausea; diarrhea; headache		55	182,000	45,600	+56	No gain
			L.N. (A. and P.M.) 360 r in 5 mos.	None	6 days			58	111,500	22,300		
					3 days			70	75,000	18,000	+21	
					6 days		S. smaller	63	45,000	9,000	+4	Improved
750	3,810			None								Improved
450	734	+11		None	4 days				67,000	5,360		Gain slight
100	2,802	+ 2		None	8 days			68	57,000	3,990		No change
000	10,855		None	None	10 days	Fever	Thrombo phlebitis	35	699,500	244,825		Died 11 days later
500			L. N. (C) 350 r	Transf.	2 days			45	101,000	19,190	+43	
			L. N. (R. and L.I.) 400 r									
			L. N. (L. A.) 150 r	Transf.	1 week			55	75,000	5,250	+25	No change

		[illegible] fatigue; failing vision	[illegible] ecchymosis			
Readm. 1½ mos. later		Feeling well except for up. resp. infection	Râles at bases; L. and S. larger; petechiæ on palate	60	167,000	10,8
(15) 66,991	50 M.	6 mos.	Weakness; insomnia; dyspnea; anorexia (iron and liver)	Pallor; L. N., S. and L.+; retinal hemorrhages	30	161,500	
Readm. 5 weeks later			Improved; syncope; edema ankles	Wt. gain; pallor râles, edema legs	45	77,500	Many
(16) 57,306	40 F.	6 mos.	Wt. loss; asthenia; anorexia	Subcyanosis; tachycardia; L. N., S. and L.+	70	181,500	17,24
Readm. 9 mos. later			Feeling well	Wt. gain	75	18,250	
Readm. 1½ mos. later			No change	As above	70	36,300	1,81
Readm. 6 mos. later			(Pneumonia in interval) weakness	Wt. gain	65	68,000	68
Readm. 4 mos. later			Feeling well; flashes; nervous	No change	75	13,500	16,11
Readm. 2 mos. later			No change	No change	60	217,000	34,72
Readm. 6 mos. later			Feeling well; amenorrhea	S. larger	58	241,500	
Readm. 4 mos. later			Pain in arms	No change	60	360,000	64,80
(17) 66,352	37 F.	4 years	Fatigue; vertigo; weakness; aching in back and left side; palpitation; dyspnea; chills; fever; sweats	Vaso-motor instability; L. N., S. and L.+	60	240,000	60,00
Readm. 1 mo. later			Greater weakness; headache; pain radiating to left shoulder	Pallor; fever; S. and L. larger	55	662,000	211,88
Readm. 9 mos. later					70	394,500	165,69
(19) 61,658	54 M.	2 years	Dyspnea; pain left chest; anorexia; emésis; fatigue	L. N., S. and L.+	70	239,500	93.5
Readm. 2 mos. later			Weakness; headache; vertigo	Pallor; smaller L. N. and S.	85	29,000	91
(20) 51,742	59 F.	1 year	Swollen lymph nodes; pruritus; weakness	L. N., S. and L.+	62	33,950	89
Readm. 6 weeks later			Somewhat better; spread of skin changes; pain	Ulcer skin; increased L. N.; râles	65	25,000	92
(23) 10,002	59 M.	1 year	Swollen lymph nodes	L. N. and S.+	78	12,970	66
(25) 10,379	57 M.	1 mo.	Cough; palpitation; dyspnea; hoarseness; anorexia; weight loss	L. N. and S.+	70	172,500	93.4
Readm. 2 weeks later			Cold better; hoarseness less; appetite better; strength better		84	146,000	92.5
Readm. 1 week later					84	28,000	84.5
Readm. 1 month later					70	107,000	92
Readm. 2 weeks later					70	159,500	94
Readm. 5 weeks later			Nocturnal sweats; otherwise progress	Wt. gain 20 lbs.; râles; S. larger L.+	70	103,000	91
Readm. 4 mos. later						123,500	96.5
Readm. 1 mo. later						178,000	96.5
Readm. 6 weeks later			Working farm	S. smaller, hard	67	92,500	99
Readm. 2 mos. later			Sl. weight loss; weaker		60	227,000	95
Readm. 1 mo. later			Recent cold	S. larger	65	184,000	96.8
Readm. 1 mo. later			Weight loss 17 lbs.		65	122,500	98.5
Readm. 2 weeks later			Cold; cough		56	233,000	94
Readm. 7 weeks later					60	95,500	94
Readm. 1 mo. later					63	115,500	94

								68	57,000	3,990		No change
000	10,855		None	None	10 days	Fever	Thrombo phlebitis	35	699,500	244,825		Died 11 days later
500			L. N. (C) 350 r L. N. (R. and L.I.) 400 r	Transf.	2 days			45	101,000	19,190	+43	
			L. N. (L. A.) 150 r L. N. (A. and P. M.) 300 r S. (A. and P.) 300 r	Transf. Transf. Iron	1 week			55	75,000	5,250	+25	No change
500	Many	+43	in 2 mos.	S. extract Transf. Transf. Iron	4 days 16 days	Slump	Increased; swelling of gums	47 47	180,000 45,000	131,400 11,250		(Died at home)
500	17,242	+28	S. (A. and P.) 1,200 r	None	6 days			70	145,000	18,850		Early gain
250	0	+27	L. N. (A. and P. M.) 850 r	None								
300	1,815	+24	L. B. 3,100 r in 3 years	None								No change
000	680			None								Sl. decline
400	16,115			None								
000	34,720			None								
500	0	+17		None	3 days				195,000	7,800		
000	64,800			None	5 days			60	152,500	15,250		Slump
000	60,000	+46	S. (A. and P.) 450 r L. N. (A. and P. M.) 400 r L. B. 450 r	None	7 days				632,000	210,666		Early gain
000	211,880	+75		None	3 days			50	528,000	110,880		Marked decline
500	165,690	(C)	*Lymphocytic Leukemia*									(Died at home)
500	93.5	+35	L. N., R. and L., C. and A. 300 r	None	7 days		L. N. smaller	70	314,500	95.5	+17	Early gain
000	91	+ 6	L. N. (L. and R. L.) and S. (A. and P.) 450 r in 2 mos.									
950	89	+38	L. N. (L. and R. A.) 700 r		11 days			62	27,500	83	+39	
			L. N. (L. and R. C.) 650 r	None	12 days			60	20,400	86.7	+28	
			L. N. (L. and R. I.) 700 r	Spleen and liver extract								
000	92	+33	L. N. (A. and P. M.) 250 r in 2½ mos.		24 days 41 days	Improved generally		57 40	57,500 33,500	96.5 94	+26	Improved
970	66	+31	No chart	Fowler's solution	4 weeks 1 week			 76	11,600 10,200	61 62	+14.6 +19.6	
500	93.4	+13.5		None								
000	92.5	+18.5		None								
00	84.5	+15.7		None								
00	92	+10.4	None	None								
00	94	+13.6	None	None								
00	91	+ 7.3	S. (A. and P.) 460 r	None								
00	96.5	+ 5.8	L. N. (L. and R. C.) 100 r									
00	96.5	+27.8	L. N. (L. and R. I.) 100 r									
00	99	+ 9	in 4 mos.									
00	95	+14										
00	96.8	+48										
00	98.5	+22										
00	94	+32										
00	94	+39										
00	94	+22										

(26)						
10,379	57 M. 1 mo.	Cough; palpitation; dyspnea; hoarseness; anorexia; weight loss	L. N. and S.+	70	172,500	93.
Readm. 2 weeks later		Cold better; hoarseness less; appetite better; strength better		84	146,000	92.
Readm. 1 week later				84	28,000	84.
Readm. 1 month later				70	107,000	92
Readm. 2 weeks later				70	159,500	94
Readm. 5 weeks later		Nocturnal sweats; otherwise progress	Wt. gain 20 lbs.; râles; S. larger L.+	70	103,000	91
Readm. 4 mos. later					123,500	96.
Readm. 1 mo. later					178,000	96.
Readm. 6 weeks later		Working farm	S. smaller, hard	67	92,500	99
Readm. 2 mos. later		Sl. weight loss; weaker		60	227,000	95
Readm. 1 mo. later		Recent cold	S. larger	65	184,000	96.
Readm. 1 mo. later		Weight loss 17 lbs.		65	122,500	98.
Readm. 2 weeks later		Cold; cough		56	233,000	94
Readm. 7 weeks later				60	95,500	94
Readm. 1 mo. later				63	115,500	94
(28)						
53,653	29 M. 2 mos.	Cold (persistent); headache; swollen lymph nodes; dyspnea; vertigo; palpitation	Pallor; distended veins right arm; nodules in neck; L. N., S. and L. +	70	49,900	65
Readm. 1 mo. later		Progressive dyspnea; pain in chest; edema left arm	Fever; nodules trunk and extrem.; petechiæ		547,000 Change trans blasti	99 s sugg ition t c type
(31)						
68,308	58 M. 17 mos.	Vertigo; progressive weakness; abd. pain; nausea	Pallor; emaciation; ax. and ing. L. N.+; hypotension	60	16,300	47
Readm. 3 1/2 mos. later		No improvement	L.+	65	17,500	48
(32)						
62,949	47 M. 3 years	Paraesthesia; night sweats; palpitation weight loss	Pallor; L. N., S. and L.+	58	101,000	96.
Readm. 1 mo. later		Well for a time; weakness; dyspnea; cough; hoarseness	L. N. smaller; weight gain	60	34,000	96
Readm. 5 mos. later		Fairly well for 2 mos.; night sweats; axil. pain; prog. weakness hemoptysis	L. N. increased	58	234,500	97
Readm. 3 mos. later		Feeling better	Wt. gain as above	60	250,000	99
Readm. 2 mos. later		Marked weakness; aphonia; anorexia; palpitation	Wt. loss; pallor; L. N. increased	45	211,500	99
(34)						
69,899	60 M. 3 mos.	Swelling in nodes; weakness; dyspnea; fever; night sweats; weight loss	Pallor; exophthalmos; L. N. and L.+ otitis media	70	42,400	89
Readm. 2 mos. later		Temporary gain; abd. discomfort; diarrhea	L. N. decreased; abdominal mass	65	28,900	84
(35)						
57,718	67 M. ?	Pain left side	L. N., S. and L.+	70	47,100	78
Readm. 2 mos. later		Well	No change	70	16,800	61
Readm. 1 mo. later		Productive cough	Gain 25 lbs.	80	24,000	71
Readm. 3 mos. later		No complaints	No change	80	16,100	63
Readm. 1 year later		Sharp pain R. U. Q.	Wt. loss; no gross change	75	18,050	46
Readm. 5 mos. later		As above; failing vision; anorexia	As above	80	26,450	33

* The following key has been employed:

CODE:	Structures	Position
	L. N.—lymph nodes	R.—right
	C.—cervical	L.—left
	A.—axillary	A.—anterior
	M.—Mediastinal	P.—posterior
	A. B. D.—abdominal	+—palpable
	I.—inguinal	
	L.—liver	
	S.—spleen	
	L. B.—long bones	
	G. B.—general body	

2,500	93.4	+13.5		None									
3,000	92.5	+18.5		None									
3,000	84.5	+15.7		None									
,000	92	+10.4	None	None									
,500	94	+13.6	None	None									
,000	91	+ 7.3	S. (A. and P.) 460 r	None									
,500	96.5	+ 5.8	L. N. (L. and R. C.) 100 r										
,000	96.5	+27.8	L. N. (L. and R. I.) 100 r in 4 mos.										
,500	99	+ 9											
,000	95	+14											
,000	96.8	+48											
,500	98.5	+22											
,000	94	+32											
,500	94	+39											
,500	94	+22											
,900	65	+25	L. N. (A. and P. M.) (L. and R. I., A., C.) 150 r in 6 days	Spleen extract	2 weeks 2 days 2 days 3 days		L. N. smaller	63	17,000 29,600 68,000	75 78 92	− 5 0 − 3 + 9	
,000	99			Spleen extract; transf.	6 days			48	31,000	98		Died 2 mos.
nge s sugges tive of ans ition to l asti c type			None										
,300	47		L. N. (L. and R. I.) (L. and R. C.) (A. M.) 300 r in 6 weeks		1 mo. 1 mo.			75 65	16,050 6,950	54 40	+38	No gain	
,500	48	+33			3 days	No change		67	11,050	39		Very weak	
,000	96.5	+44	None X-ray	Lymph node pulp	3 weeks 11 days		L. N. larger L. N. much smaller	80 58	158,250 63,000	97.5 98	+27 +30	No gain Early gain	
,000	96		X-ray		3 days 3 days				16,700 4,880	80 82	+31		
,500	97	+58	X-ray 900 r L.N. (L. and R.C.) L.N. (L. and R.A.) 800 r L. N. (A. and P. M.) 950 r		2 weeks			67	211,500	98.5		Slump	
,000	99		L. N. (L. and R. I.) 1,250 r in										
,500	99	+51	1 year		11 days	Lost ground			151,000	98		Failing	
,400	89	+49	L. N. (R. and L. I.) 600 r	None									
			L. N. (R. and L. C.) 600 r		4 days			75	54,500	82	+12		
			L. N. (R. and L. A.) 600 r		7 days			80	76,000	81	+13		
,900	84	+29	L. N. (R. and L. M.) 600 r in 2 mos.		3 days				41,000	85	+ 9	Early gain	
					15 days			70	27,800	82	+16		
,100	78	+29	L. N. (A. and P. M.) 700 r		17 days				26,050	68		Gain	
,800	61		L. N. (A. and P. abd.) 200 r	None									
,900	71		L. N. (R. and L. I.) 950 r										
,100	63	+20	L. N. (R. and L. C.) 600 r in 2										
,050	46	+23	years										
,450	33	+19											

Readm. 3 mos. later		Feeling better	Wt. gain as above	60	250,000	99
Readm. 2 mos. later		Marked weakness; aphonia; anorexia; palpitation	Wt. loss; pallor; L. N. increased	45	211,500	99
(34) 69,899	60 M. 3 mos.	Swelling in nodes; weakness; dyspnea; fever; night sweats; weight loss	Pallor; exophthalmos; L. N. and L.+ otitis media	70	42,400	89
Readm. 2 mos. later		Temporary gain; abd. discomfort; diarrhea	L. N. decreased; abdominal mass	65	28,900	84
(35) 57,718	67 M. ?	Pain left side	L. N., S. and L.+	70	47,100	78
Readm. 2 mos. later		Well	No change	70	16,800	61
Readm. 1 mo. later		Productive cough	Gain 25 lbs.	80	24,000	71
Readm. 3 mos. later		No complaints	No change	80	16,100	63
Readm. 1 year later		Sharp pain R. U. Q.	Wt. loss; no gross change	75	18,050	46
Readm. 5 mos. later		As above; failing vision; anorexia	As above	80	26,450	33

* The following key has been employed:

CODE:	Structures	Position
	L. N.—lymph nodes	R.—right
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	I.—inguinal	
	L.—liver	
	S.—spleen	
	L. B.—long bones	
	G. B.—general body	
	S. T.—sternum	
	D. S.—dorsal spine	
	T.—thigh	

r—roentgen measured in air. (Available in all cases treated after C

0,000	99		L. N. (L. and R. I.) 1,250 r in									
1,500	99	+51	1 year		11 days	Lost ground			151,000	98		Failing
2,400	89	+49	L. N. (R. and L. I.) 600 r	None								
			L. N. (R. and L. C.) 600 r		4 days			75	54,500	82	+12	
			L. N. (R. and L. A.) 600 r		7 days			80	76,000	81	+13	
8,900	84	+29	L. N. (R. and L. M.) 600 r in 2 mos.		3 days				41,000	85	+ 9	Early gain
					15 days			70	27,800	82	+16	
7,100	78	+29	L. N. (A. and P. M.) 700 r		17 days				26,050	68		Gain
6,800	61		L. N. (A. and P. abd.) 200 r	None								
4,000	71		L. N. (R. and L. I.) 950 r									
6,100	63	+20	L. N. (R. and L. C.) 600 r in 2									
8,050	46	+23	years									
6,450	33	+19										

ted after Oct. 1, 1928.)

The conventional x-ray deep therapy technic was used; the tube potential amounted to either 160 or 189 kv. (valve tube and condenser equipment), with a filter of 0.5 mm. Cu +1.0 mm. Al. The quality of radiation corresponded to a half value layer in Cu = 0.75 mm. and 1.0 mm., respectively. For the exposure of the spleen, long bones, and lymph glands the F.S.D. equaled 50 cm.; for general body exposure, however, it was from 60 to 100 cm. Since, according to the observations of Hoffman and Craver (29), no marked difference in the duration of life and percentage of efficient life could be detected, whether the spleen or long bones, or both were exposed, in myelogenous leukemia, we usually expose all of these areas in an attempt to reduce the skin surface dose over one particular area to a minimum. The dose applied per field varies from 100 to 200 r (in air) for local areas, and from 25 to 50 r (in air) for general body exposure. Not more than three areas in the case of local exposures, and not more than two areas in the case of general body exposure are irradiated at one sitting. It is our opinion that such a conservative treatment best serves the interest of the patient, particularly since even extremely high doses cannot cure the disease. A good general rule is to keep these patients as comfortable as possible, with as little irradiation as is required for that purpose. In this respect, we are in agreement with Chamberlain (30), Krause (31), and McAlpin, Golden and Edsall (32).

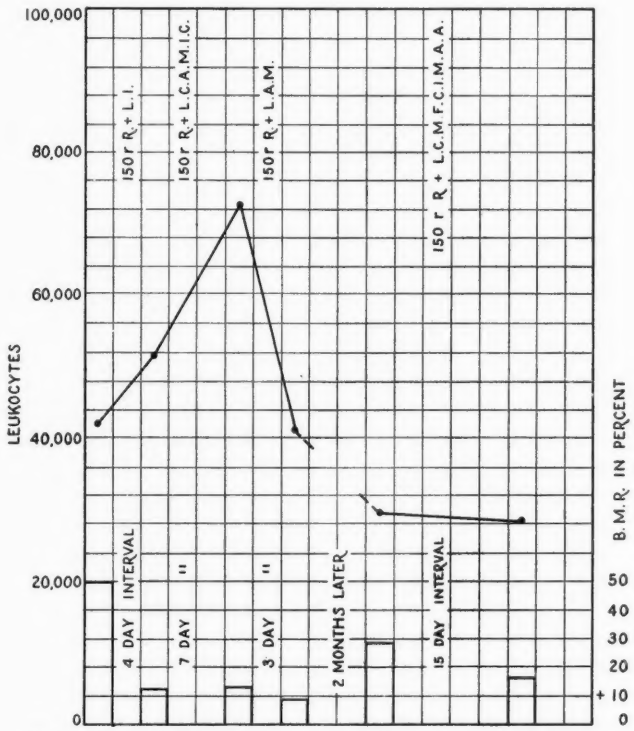

Chart I. Arranged from Case 4, chronic myelocytic leukemia, and demonstrating the relationship of the basal metabolic rate to the total leukocyte and immature cell counts under roentgen therapy (see Table II-*B* for clinical details). For interpretation of symbols of areas treated and dosage, see footnote attached to Table II.

This leads us to the question of technic:

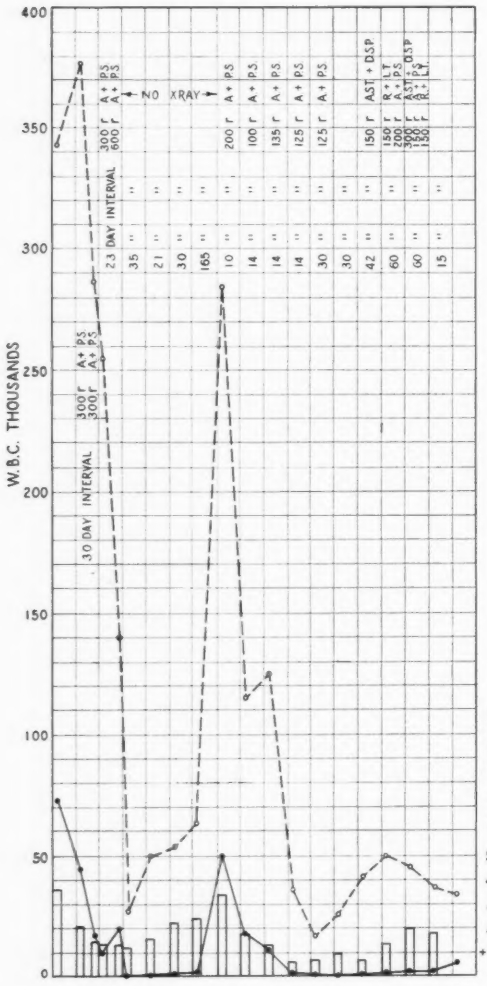

Chart II. Arranged from Case 34, a chronic lymphocytic leukemia, demonstrating the relationship of the basal metabolic rate to the total leukocyte count. (See Table II-*C* for clinical details.) For interpretation of symbols of areas treated and dosage, see footnote attached to Table II.

low, medium or high voltage therapy. There is no doubt that, in the early stage, moderate potentials (130 kv., 0.25 mm. Cu) will produce good results; however, it is necessary to observe each patient carefully, and, as soon as there is less response during a series of treatments than in the beginning, a change to high voltage therapy (from 160 to 200 kv.; 0.5 mm. to 1.0 mm. Cu) should be made. A typical example is given in Table III.

During the last six years, the general body exposure has been used by a relatively small group of radiologists in the treatment of malignant neoplasms, including leukemia, Hodgkin's and allied diseases. It was first suggested by Dessauer (33), and later taken up by Teschendorf (34), and others. Heublein (35) started an extensive study of this method in the treatment of malignant disease, exposing patients continuously over periods of several days to three weeks, at a distance of about five meters between the patient and the tube. Craver and MacComb (36) recently rendered a report on 134 cases treated with this method over a period of two years. They came to the conclusion that, in radiosensitive diseases, as leukemia, Hodgkin's disease, multiple myeloma, and lymphoblastoma, worthwhile results can be obtained, but little is to be expected in radioresistant neoplasms. Of course, great caution is necessary in the use of the general body exposure, because of the high rate of absorption, due to the large areas exposed to the roentgen rays.

Up to this date we have not employed general body exposure routinely in all

TABLE III

Date	W. B. C.	r	Field	Remarks
Feb. 4, 1932	234,000	1,270	Spleen and chest	From Feb. 4 to March 7, 1932, 125 kv.; 0.25 mm. Cu
March 14, 1932	57,000			
May 2, 1932	93,000	300	Chest	
June 17, 1932	131,000	300	Spleen	
Sept. 1, 1932	138,000	250	Spleen	
Nov. 25, 1932	118,000	300	Spleen	
Feb. 17, 1933	142,000	275	Chest	
May 15, 1933	284,000	200	Spleen	
June 6, 1933 to July 17, 1933		1,050	Spleen and mediast.	High voltage therapy, 180 kv.; 0.5 mm. Cu
Aug. 11, 1933	29,000			

cases, but reserved it for those which did not respond to the usual methods, particularly in the later stage of the disease. Several striking remissions were seen among such cases, and the blood count of one patient is shown here to demonstrate this fact (Table IV).

Involvement of the bones, which is seen occasionally, may successfully be treated by high voltage roentgen rays; according to Craver and Copeland (37), there is often relief from pain as well as complete repair of the diseased bone.

Priapism, a rare complication of myelogenous leukemia, is probably due to a thrombosis in the corpora cavernosa. Several cases have been reported, which received relief from local exposures over the penis (from 120 to 150 r), combined with exposures of the spleen (38). According to some observers, the lesion is apparently not central since general anesthesia does not affect it.

A different approach to the problem of treating leukemia has been offered by several Russian investigators (39 and 40). They found that patients with toxic symptoms showed a high uric acid content in the blood. Irradiation of the kidneys produced striking remissions. They leave the question open as to whether this was due to a direct effect of roentgen rays on the kidney function, or to a reduction of a leukemic infiltration of the parenchyma of the secreting organs. We have no personal experience with this method.

SUMMARY

A review of the experiences occurring in the State of Wisconsin General Hospital, in an attempt to correlate the basal metabolism with the patient's clinical condition, leukocyte count, and the number of immature cells in leukemia, is presented. Adequate data were obtained on 35 patients. A close parallelism between the basal metabolic rate and the leukocyte count was occasionally noted, but this was not the rule. A closer relationship of the metabolic rate to the general clinical condition was more frequent, but here too there was a lack of regularity. It was found that, though the basal metabolic rate bore more than a casual relationship to the patient's state of well being, it certainly was not an infallible guide. The basal metabolic rate is an aid in deciding upon the time of therapy in leukemia, but should be used in conjunction with other findings.

The excellent hematologic response to general body exposure is reported in one case.

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TABLE IV

Date	W. B. C.	r	Field	Remarks
May 15, 1932	48,850	1,200	Spleen and long bones	From May 26 to June 13, 1932
July 14, 1932	13,000			X-ray in September, 1932, and May, 1933
				Highest count, 20,000
Sept. 19, 1933	110,000	400	Spleen and long bones	
Sept. 27, 1933	112,500			
Oct. 12, 1933 to Nov. 1, 1933	102,550	100	Ant. and post. body	Eight sittings of 25 r each
Jan. 8, 1934	17,000			
May 14, 1934	85,000	100	As above	As above
Sept. 7, 1934	8,500			

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THE INCIDENCE OF PEPTIC ULCER ASSOCIATED WITH DUODENAL STASIS

By JULIUS FRIEDENWALD, M.D., *and* MAURICE FELDMAN, M.D., *Baltimore*

From the Gastro-enterological Clinic of the Department of Medicine, University of Maryland

MUCH interest has been manifested in recent years concerning various affections of the duodenum. Among these, chronic duodenal stasis plays a significant rôle. In our study of this condition (1), the frequent occurrence of ulceration associated with duodenal stasis has been brought to our attention. In 24 of our cases, reported in 1929, peptic ulcers occurred in three (12.5 per cent).

In a review of the literature numerous instances of this association are recorded.

As far back as 1909, Codman (2) suggested that chronic obstruction of the duodenum may predispose to the formation of ulcer by causing stasis and the consequent infection of the duodenal contents, and by the forcing back of irritating pancreatic secretions into the pyloric region.

Kellogg (3) likewise notes that ulcerations of the stomach and duodenum are observed in a considerable percentage of cases of duodenal stasis and obstruction in which operation has been performed. In 41 instances observed by Kellogg and Kellogg, ulceration was noted in eight (19.5 per cent). Wilkie (4) confirms this observation and is also of the opinion that this condition may act as a predisposing cause of ulceration. In 17 instances of duodenal stasis, he found three of duodenal and one of gastric ulcer, and in a later study of 75 cases an associated duodenal or gastric ulcer in 19 instances (25 per cent). Hurst and Briggs (5) found three duodenal and one gastric ulcer in eleven cases of duodenal stasis, and consider that the friction produced by the to and fro movements of the duodenal contents, or the result of this condition in an individual with a constitutional hyperchlorhydria, can be considered as an additional predisposing cause of ulcer.

Sloan (6), in analyzing a series of 264 cases of duodenal ulcer, noted an associated partial duodenal obstruction in 52 instances (19.7 per cent), in all of which cure was brought about by appropriate operative procedures. He concludes that stasis or partial obstruction at the duodenojejunal junction predisposes to duodenal ulcer or renders the conditions favorable for its development. Instances of an association of chronic duodenal stasis with ulcer have been recorded by Rowlands (7), Jones (8), Ryle (9), Higgins (10), del Valle (11), Kilgore (12), Bockus (13), Miller (14), Shattuck and Imboden (15), Barling (16), Lane (17), Deaver (18), Duval (19), Zoepffel (20), Ochsner (21), and others.

The etiology of duodenitis and duodenal ulcer and their relationship to duodenal stasis is a matter of considerable interest. It has been generally accepted that chronic gastritis and duodenitis precede the formation of gastric and duodenal ulcers; thus the importance of duodenitis in this respect is easily understood. Bockus (13) and Miller (14) have called attention to this condition, though it is not always possible to determine whether the duodenitis precedes or follows the stasis.

A number of investigators have attempted to demonstrate the association of ulcer and duodenal stasis experimentally in animals. Talma (22) and Bolton (23) were able to produce duodenal as well as gastric ulcers by constricting the duodenum. In 1927, Slocumb (24) produced ulcers in 12 out of 16 dogs by obstructing the duodenum. In Dott and Lim's (25) experiments, pyloric occlusion was produced and followed by gastrojejunostomy. Jejunal ulcers developed in 90 per cent of their experimental animals. Both clinical and experimental evidence indicates that the association of duodenal ulcer with duodenal stasis is not uncommon.

In order to establish the incidence of this

association a further analysis of our cases was made. This study included 80 cases of duodenal stasis, 64 males and 16 females, the ages ranging between 17 and 70 years. The highest incidence of this affection occurred during middle life, that is, between 30 and 40 years. The following table presents these cases arranged according to age and sex:

Ages	Male	Female
20–30	5	1
30–40	23	5
40–50	19	7
50–60	16	3
60–70	1	0
	64	16

Of the cases of duodenal stasis, nine were of the persistent and 71 of the intermittent type.

As has been previously described, the stenosis may involve the first, second, third, or fourth portions of the duodenum. It was present in the second part in 65 of our cases, in ten in the third, and but twice in the first portion.

Of the 80 cases, duodenal ulceration was present in 35 instances, and there was evidence of duodenal dysfunction, irritable duodenum and spastic duodenum, and duodenitis in seven. In this series, the ulceration occurred predominantly in the first part of the duodenum. It is also of interest to note that gastric ulcer occurred in eight instances.

Among other associated conditions observed were cholecystitis in five, abdominal adhesions in four, mucous colitis in 20, and visceroptosis in 21.

The symptoms ordinarily observed in chronic duodenal stasis were present in most instances, though these are by no means always characteristic. In many instances there are periodic attacks of nausea and vomiting, so-called bilious attacks, which have been recurring over a period of years, often since childhood. These attacks are frequently preceded by intense constipation and are often accompanied by headaches and migraine attacks. The constipation is occasionally replaced by intermittent outbreaks of diarrhea. When ulceration does not occur, pain may be absent or mild and may show no special relation to the ingestion of food. Changes in posture may in some instances afford great relief from symptoms. Occasionally the liver enlarges and symptoms of cholecystitis may occur.

Due to the frequency of these attacks, loss of weight and strength is not unusual and neurasthenic symptoms are likely to supervene. During the interval of freedom from these attacks which may extend over a period of some days, the patient may enjoy comparatively good health. While in the milder intermittent types associated with infrequent attacks, the pylorus retains its normal tonicity, and regurgitation takes place only when the obstruction permits an excessive amount of duodenal contents to accumulate, in the more chronic and severe forms the pylorus becomes patent and the dilatation extends up into the stomach. In many of these cases the pylorus remains constantly patent and is greatly increased in diameter, often to such a degree that nausea and vomiting of biliary contents becomes more or less persistent and even vomiting of the retention type may occur. Following meals, the patient may complain of fullness, heaviness, distention, and eructation of gas, and not infrequently of pain which may extend over the entire abdomen or be limited to the epigastrium, or to the right upper or lower quadrants of the abdomen. Headaches become incessant, and migraine attacks with biliousness and malaise, faintness and dragging sensations are not infrequent. The bowels are extremely constipated and anemia and loss of weight and toxic as well as neurasthenic symptoms often supervene. Occasionally an urticarial eruption is observed. The symptoms vary somewhat according to the location of the obstruction. When obstruction occurs at the first portion of the duodenum, the symptoms largely resemble those of pyloric stenosis. In other instances, pain extending over the gall-bladder region, with enlargement of the liver and jaundice, may

erroneously give rise to the diagnosis of cholecystitis. In still others, pain may occur several hours following meals, together with symptoms of hyperacidity, and consequently the incorrect diagnosis of ulcer may be made, although, as we have already emphasized, ulcer is frequently associated with this condition.

Occasionally, the attacks may disappear for periods of months or even years, during which time the patient may enjoy good health, then a relapse may occur following an acute illness, such as "the grippe" or any disease producing emaciation. The discomfort and pain which are usually present in these cases during an attack and which are frequently aggravated in the recumbent posture may be relieved at times by elevating the pelvis or by having the patient assume the knee-chest posture. Distention of the duodenum is in itself sufficient to produce subjective symptoms and occasion reverse peristaltic waves, which frequently induce eructations, nausea, vomiting, regurgitation of duodenal contents into the stomach, as well as certain vascular and neuro-muscular symptoms.

In the very aggravated types with gastric retention and profuse bilious vomiting a high degree of toxemia may occur. This profound toxemia may be associated with marked dehydration, shock, and, at times, attacks of tetany and may occasionally lead to a toxic nephritis.

Among the most common complications of duodenal stasis are gastric ulcer, gastric dilatation of varying degrees, cholecystitis, pancreatitis and mucous colitis, but the most frequent are duodenal ulcer to which our attention is especially directed in this paper. As we have already pointed out, duodenal ulceration and other duodenal changes occurred in 42 of our 80 cases (52.5 per cent).

In addition to the symptoms of duodenal stasis already described, the presence of ulceration is ordinarily manifested by the signs usually present in that affection. These consist of evidences of hyperacidity, pylorospasm, hunger pain, an epigastric painful area and gross or occult blood in the stools. Many of these symptoms, however, are frequently masked or absent, so that the presence of ulceration may not even be suspected until such complications as hemorrhage or perforation occur. In other instances it may only be revealed following the roentgen-ray investigation.

Definite symptoms of ulceration occurred in 21 (26.2 per cent) of our cases of duodenal stasis. Symptoms of hyperacidity were present in 19 instances, an epigastric painful area in 25. Blood was present in the stools in 15 instances, in three of which it occurred in massive form, in six as tar-colored, and in 12 as occult.

Of the 42 cases in which ulceration or other duodenal changes occurred, the gastric acidity was normal in 17 instances; hyperchlorhydria occurred in 23, and hypochlorhydria in two.

In making the diagnosis it is important to establish both the presence of the duodenal stasis as well as the ulceration. As a rule in duodenal stasis the patient is observed to be slender, of the asthenic type, presenting the narrow costal angle usually observed in visceroptosis. The stomach and colon are prolapsed and atonic, and a succussion sound is readily elicited over the gastric area. Tenderness is ordinarily noted in the epigastrium or to the right or left of the umbilicus and an epigastric protuberance is occasionally observed. At times in advanced cases there is a general abdominal distention, and the duodenal dilatation may be so marked as to present the sensation of a tumor mass to the palpating hand. When the stomach has become dilated, peristaltic movements may be observed over its area. Even in those instances in which vomiting does not occur, the stomach may contain large quantities of bile. It is important in this affection to examine the vomitus for the presence of bile and pancreatic juice. Inasmuch as the ducts empty into the duodenum, the constant presence of these secretions in the vomitus would indicate duodenal obstruction. Dilatation of the duodenum should be suspected when the

symptoms described above are observed in an asthenic patient of the enteroptotic type.

While the diagnosis is possible in rare instances from the history and physical findings alone, the roentgenologic evidence is far more conclusive. The roentgenologic signs of this affection are well defined and extremely characteristic, and a positive diagnosis can be made only by means of this procedure. The roentgenologic findings are based largely upon fluoroscopic examinations, by means of which changes in motility can be carefully observed. The films, however, record the definite anatomic changes. The fluoroscopic examination is usually most satisfactorily made with the patient in the upright posture when viewed semilaterally with the right side nearest the screen. However, the duodenal dilatation can ordinarily be well observed also when the patient is recumbent, and satisfactory films may be obtained in either position. Delay in the barium is not infrequently overcome by change in posture of the patient, which can readily be observed under the screen. Peristaltic and rhythmic contractions assure a passage through the duodenum of its contents under normal conditions in from eight to ten seconds; however, in this condition when an accumulation of barium occurs in the duodenum at any point, the mass is divided and passes in opposite directions along this organ. Definite symptoms are associated with or follow immediately these reverse movements, and retention in the duodenum can be considered positive when the barium is retained longer than a period necessary to complete the passage of two gastric peristaltic waves. In the more marked cases, however, gastric as well as duodenal six-hour residues of the barium are not uncommon.

The dilated duodenum can frequently be more satisfactorily observed from one and a half to two hours following the barium meal, but ordinarily observations over a period of thirty or forty minutes are sufficient to establish the diagnosis. At times, evidences of antiperistalsis with regurgitation of the barium meal into the stomach are noted fluoroscopically. In order to eliminate the presence of duodenal stasis, the duodenum must be observed at intervals over a period of at least from thirty to forty minutes, and in some instances for varying intervals between two and five hours. The presence of this condition is suggested when the duodenum is constantly visible, during the period of emptying of the stomach, when varying degrees of dilatation may be seen.

In stenosis between the first and second portions of the duodenum, the duodenal bulb may be elongated and dilated, and will present evidence of delay in the expulsion of the barium. The first portion may also be distorted, occasionally giving rise to the appearances noted in ulcer. In some instances, visualization of the third portion of the duodenum may be obscured, due to an enteroptosis, and lateral or oblique views must then also be obtained. The stomach is often prolapsed in these instances, and may present a six-hour as well as an eighteen-hour retention of the barium.

Obstruction between the second and third portions of the duodenum is usually more readily visualized. In the late stage of stenosis, a rather characteristic picture is observed from four to five hours following the barium meal in the form of a saucer-shaped residue in the duodenum.

The duodenum may be dislodged downward or it may present itself forward, being freely movable in the abdomen. The barium passes without difficulty through the first part of the duodenum to the transverse portion where it remains stationary. At this point, violent peristaltic movements (the so-called writhing duodenum) are noted as if the barium were forcing its passage through some obstruction, when suddenly reverse peristalsis takes place and the barium is carried back into the duodenal bulb. These phases are rapidly repeated, and after a certain delay portions of the barium are forced through the area of obstruction into the jejunum. Above

the area of apparent obstruction dilatation of the duodenum is noted.

Obstructions of the fourth portion of the duodenum at the duodeno-jejunal junction are not so easily visualized but may be readily observed by examining in special positions.

Finally, in considering the diagnosis it should be recognized that duodenal stasis is not a rare condition and that it is very frequently overlooked. In some instances, in fact, the affection may continue on for long periods without presenting symptoms. It is always important, however, in order to be certain that the stasis is permanent that repeated roentgen-ray examinations be made, more especially in the intermittent type.

Special care must likewise be exercised in order to determine the presence of an associated duodenal ulceration. The roentgenologic examination requires both a fluoroscopic investigation as well as a study of the films. Attention must also be directed to the fact that such affections as cholelithiasis, cholecystitis, chronic appendicitis, and pyloric stenosis may be excluded or their presence noted as complications by means of more complete roentgenologic studies.

The treatment involves the management of the duodenal stasis as well as of the ulceration. In many instances medical management is quite satisfactory, and with conservative treatment marked improvement frequently takes place. This is ordinarily observed in the milder types in which the symptoms occur intermittently and are followed by periods of relief.

Diet plays an important rôle in the management of these cases. The food should be bland, given in small amounts and at frequent but regular intervals, and be of a high caloric value in order to secure a gain in weight, especially of intra-abdominal fat. In order to accomplish the best results absolute rest in bed for from four to six weeks is indicated. Inasmuch as many of these patients are of the visceroptotic type, the usual treatment ordinarily employed for this affection should be instituted. In addition, postural treatment is of great advantage following the ulcer treatment, to which gradually increasing exercise is added in order to strengthen the abdominal muscles.

Duodenal lavage and feeding are frequently of great benefit. In the milder types, when a rest cure treatment is found impossible, in addition to a modified ulcer diet the patient should be instructed to assume the knee-chest posture immediately upon the onset of obstructive symptoms. In other instances relief is obtained if the patient reclines one or two hours following meals, the foot of the bed being elevated, this position to be continued until the attack disappears. Through these procedures the abdominal organs tend to gravitate upward, and the drag upon the duodenum is at least temporarily overcome. The patient should be advised to wear a well-fitting abdominal support when up and about. It is also well to impress him with the facts that his general nutrition must be maintained and that his diet must continue to be carefully regulated, inasmuch as symptoms are otherwise apt to recur.

In the severe types, accompanied with excessive pain or vomiting, in which dehydration, reduction of blood chlorides and increase in non-protein blood nitrogen occur, the intravenous administration of sodium chloride with glucose is advised.

When the symptoms are severe and when medical treatment no longer suffices in affording relief, surgical intervention is indicated.

SUMMARY AND CONCLUSIONS

From this study it is evident that duodenal ulceration and other duodenal complications occur with great frequency in association with duodenal stasis. In this series ulceration was present in 43.75 per cent and other duodenal changes in 8.75 per cent of cases, gastric ulcer in 10 per cent. There has been considerable discussion as to which is primary. Now that it has been established that duodenitis ordinarily precedes the formation of ulcer, it seems safe

to conclude that as a result of the stasis duodenitis occurs, and in consequence of the latter, ulceration. Considerable experimental evidence is at hand as proof of this conclusion, from the work of Talma (22), Bolton (23), and Slocumb (24) already referred to.

Finally, inasmuch as ulcer is so commonly observed in association with duodenal stasis, and in consequence the symptoms are so frequently masked, it is highly important to carry out a most complete roentgen-ray study in all instances of duodenal stasis, in order to establish the presence of ulceration. The diagnosis can be definitely arrived at only by means of roentgen-ray examination.

In the treatment, both the stasis and ulcer must be considered and treatment directed to both conditions.

1013 N. Charles St.
2425 Eutaw Pl.

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DUODENAL DIVERTICULA

By ARTHUR S. UNGER, M.D., *and* M. H. POPPEL, M.D., *New York City*

From the Department of Radiology, Gouverneur Hospital

DIVERTICULA occur in all portions of the digestive tract in the following order of frequency: colon, jejuno-ileum, esophagus, pharynx, duodenum, and stomach.

According to Kellogg, priority for describing duodenal diverticula belongs to Chomel, who described the first case in 1710 in which the pouch was secondary to a cholecystoduodenal fistula. It was first recognized roentgenographically in 1912, and since then most of the roentgenologic data have been contributed by Case, Cole, Spriggs, Marxer, and others. Kellogg collected 140 cases up to 1933, of which 47 were proved by operation.

The duodenum, beside being subject to the factors predisposing or leading to the production of diverticula elsewhere in the digestive tract, has special problems depending upon the following: (1) The penetration of its wall by the biliary and pancreatic ducts, (2) the sudden propulsion of gastric contents against its wall, and (3) the sudden increase in tension caused by the closure of the pylorus.

DIVERTICULA, CONGENITAL OR ACQUIRED

Congenital Type.—That diverticula may be congenital is suggested by the following: (1) their normal formation during the development of the liver and pancreas; (2) by the association of abnormal pouches with other anomalies, such as esophageal and bladder pouches and stricture of the digestive tract, and (3) by the presence in some of them of all the coats of the normal duodenum.

The congenital origin of some diverticula is proved by the demonstration of duodenal diverticula in the human embryo as well as in that of the pig and rabbit (Lewis and Thyng).

Acquired Type.—Even though some investigators maintain that the majority of diverticula are congenital, and explain their recognition later in life by the fact that they persist without symptoms until they attain considerable size or until complications develop, there is, however, evidence to suggest that many diverticula are acquired because of the pressure or traction upon a wall weakened by anatomic peculiarities or pathologic processes. The following facts are all suggestive of an acquired origin: (1) these pouches are usually in close relation to the sheaths of large vessels; (2) they are near the bile and pancreatic ducts; (3) a muscular coat is absent; (4) they occur in individuals who are cachectic or past middle life, and (5) they occur without changes in the liver or pancreas.

Hansemann artificially produced diverticula in senile intestines by ligating segments, and filling with water and increasing the intra-intestinal pressure. After reaching the limit of resistance, a hernia forms.

Klebs first called attention to the relation between blood vessels and false diverticula, the latter being located at the points of penetration of the mesenteric vessels. He attributed their formation to the traction of the intestine upon the mesentery, while Good, Hanau and Hansemann attributed the formation to excessive pressure from the intestinal contents.

The preponderance of diverticula of the duodenum at the point of entrance of the bile and pancreatic ducts is due to the separation of muscle fibers, thereby weakening the wall.

Perry and Shaw distinguish two types of acquired pouches. One is caused by traction of adhesions; in the other, the starting point may be an ulcer, the base of which yields to pressure. The ulcer acts by weakening the muscle layer, and in an early stage there may be pouching on both

sides of the scar, but in a more advanced stage this is transformed into a single pouch with the ulcer at its apex.

shaped, sessile, globular, or spherical. Diverticula are usually single but as many as five have been described in the same pa-

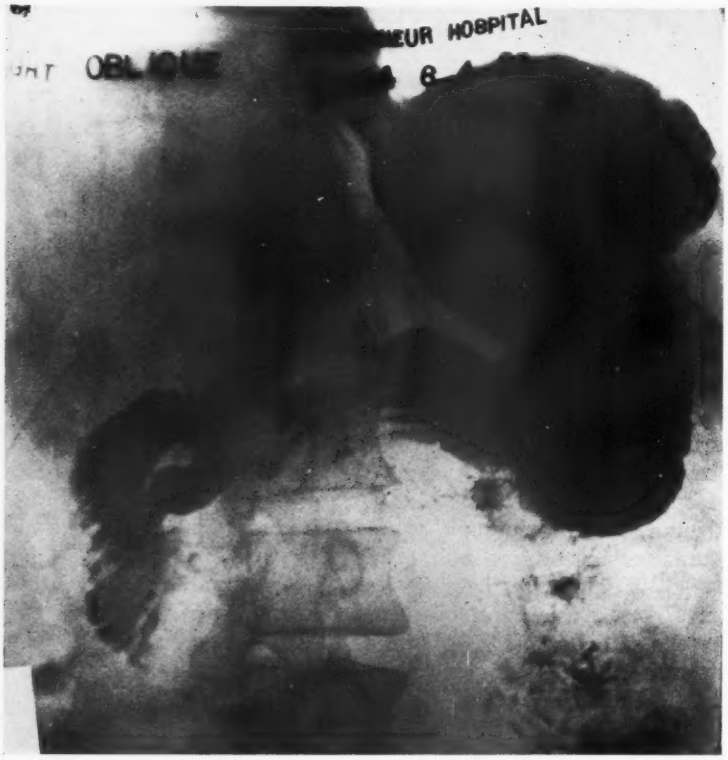

Fig. 1. Diverticulum of the first portion of the duodenum.

Perry and Shaw also point out that the duodenum is the only portion of the small intestine in which ulcers produce pouches and suggest that after closure of the pylorus, the pressure of the duodenum when contracting will cause greater stress than is apt to result elsewhere in the small intestine.

PATHOLOGY

A true diverticulum is composed of all the layers of the normal intestine. A false diverticulum is a hernia of the mucosa and submucosa through the muscularis and is covered with serosa. Congenital diverticula are all true, while the acquired may be false or true.

A diverticulum is variously described as cylindrical, finger-like, pyriform, funnel-

tient (Baldwin). They may be found in any portion of the duodenum, though most frequently located in the second portion. In Kellogg's series of 140 cases, 69 were in the second portion, 17 in the third portion, 21 in the first portion, and 4 in the fourth portion. In the 21 cases involving the first portion, illustrations involving all portions of the wall were individually demonstrated.

COMPLICATIONS

Chronic inflammation of a diverticulum is frequent, but acute inflammation, suppuration, and gangrene are rare.

Hemorrhage, with or without ulcer, dilated stomach with retention of food, bile tract lesions, and pancreatitis have been mentioned but are very rare.

Adhesions between the sac and pancreas or other structures are not unusual.

SYMPTOMS

There is no clinical syndrome characteristic of duodenal diverticula. In many instances symptoms are entirely lacking. In cases recognized roentgenographically, however, it is not unusual to observe retention in the sac, which produces vague digestive discomfort. Symptoms may be due to distention or inflammation of the sac and the surrounding structures, or to pressure exerted by the distended sac upon the adjacent structures. Pain is the most constant symptom; it may consist of a dull ache, a dragging sensation, or it may be boring in character; the onset is gradual, reaching its maximum shortly. Pain is usually referred to the right upper quadrant, to the mid-line, or to the tip of the ensiform. It is recorded as occurring one, two, three, or four hours after meals, sometimes being relieved by taking food or alkalies, or by lying flat on the abdomen.

DIAGNOSIS

Roentgen examination offers the only means of definite diagnosis prior to the opening of the abdomen. According to Case, diverticula are suggested by the following findings:

(1) A more or less spherical shadow lying near or within the concavity of the duodenal shadow; some are found on the convex side.

(2) Identity of this shadow as being separate from the duodenum, yet in definite relation to it.

(3) Sometimes persistence of the shadow for hours or even days after clearing of the stomach.

(4) In certain cases, movability of the shadow about a fixed point in the epigastrium.

(5) Usually no point tenderness coinciding with the shadow, though this is not always true.

When a duodenal diverticulum is roentgenographically demonstrable, when retention of barium is marked, and the pouch is tender to pressure, the diagnosis of duodenal diverticulitis is justified.

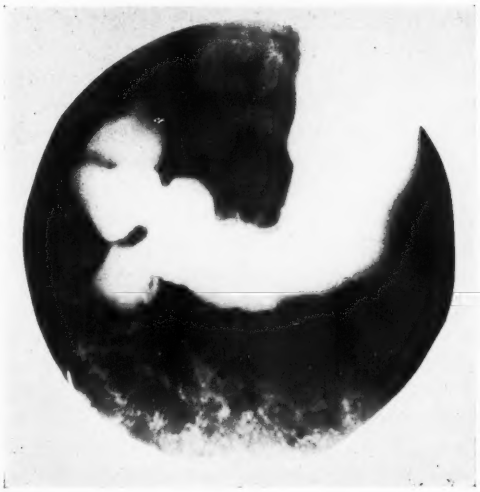

Fig. 2. Diverticulum of the second portion of the duodenum.

CASE REPORTS

Case 1. A white male, aged 40 years, was admitted to Gouverneur Hospital on June 1, 1935, complaining of acute colicky abdominal pain of three days' duration, which was centered around the umbilicus and was especially severe when the patient assumed the erect posture. There was neither nausea nor vomiting.

The patient's past history was negative except for abdominal distress about twelve years previously, which disappeared permanently after a few weeks of a self-prescribed diet of milk and crackers.

A physical examination was negative except for tenderness around the umbilicus. There was no rigidity or rebound tenderness.

Laboratory data revealed that the urine and blood picture showed no variation from the normal.

Roentgen examination revealed a pyriform shadow filled with barium, extending from the inferior or greater curvature side of the duodenal cap. Although the shadow was separated from the duodenal cap it was connected with it by a narrower por-

tion (neck of diverticulum). Emptying of the sac was accomplished by palpation; otherwise, it remained filled during the fluoroscopic and roentgen examinations.

The conclusion reached at this time was diverticulum of the duodenal cap.

Operative Report.—The patient was operated upon and a diverticulum, as described in the roentgen report, was found on the greater curvature side of the duodenal cap. The diverticulum contained all the coats of the normal duodenum and showed no signs of inflammation.

The conclusion reached was congenital diverticulum.

Case 2. A female, aged 38 years, whose past history was essentially negative except for vague digestive discomfort for the past few years. A physical examination was negative except for tenderness around the umbilicus. There was no rigidity. The clinical impression was duodenal ulcer.

Roentgen examination revealed a large spherical shadow lying within the concavity of the duodenal shadow. This shadow was separated yet in definite relation to the second part of the duodenum and connected to it by a narrow shadow (neck of diverticulum). It persisted and was demonstrable for 24 hours after the duodenum had emptied.

The conclusion reached at this time was diverticulum of the second portion of the duodenum.

Operative Report.—The patient was operated upon and a large diverticulum, as described in the roentgen report, was demonstrated. It was found to be of the acquired type.

The conclusion reached was acquired diverticulum.

GENERAL CONCLUSIONS

Two cases of diverticulum of the duodenum have been presented.

Inasmuch as there is no clinical syndrome characteristic of duodenal diverticulum, the roentgen examination of the gastro-intestinal tract offers the only means of definite diagnosis prior to the opening of the abdomen.

Finally, we would like to stress the importance of the gastro-intestinal series in all abdominal cases in which the clinical picture is not adequately explained.

Gouverneur Slip and Water St.

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MEDIASTINAL TUMORS AND MALIGNANT LYMPHOMA

By ISIDORE ARONS, M.D., D.M.R.E. (Cant.), *New York City*

THE mediastinum may be compared to the cranial cavity in that both contain organs of vital importance. In the mediastinal space are housed all the thoracic viscera excepting the lungs. Within the mediastinum are contained the heart and the large vessels which convey blood to and from the heart, the trachea and bronchi, the esophagus and thoracic duct, the important vagus, splanchnic, and phrenic nerves, as well as numerous lymph nodes. This part of the thorax is thus fairly well crowded, and it is obvious that any minute displacement of one organ will have far-reaching effects on neighboring structures. Furthermore, because the various mediastinal organs have various individual functions, the clinical picture presented by mediastinal pathology may consist of a conglomeration of signs and symptoms, which may be so confusing as to make a correct diagnosis not only difficult, but in many cases impossible. However, since the advent of the roentgen ray, mediastinal lesions can often be visualized and correctly diagnosed and proper treatment instituted.

It is not within the scope of this paper to discuss the entire realm of mediastinal pathology. I shall limit myself, therefore, to a discussion of the common primary mediastinal tumors, some cases of which will be presented below.

The standard classification of the primary mediastinal tumors is as follows (1):

(A) Benign	(1)	Dermoid cysts.
	(2)	Other cysts, including echinococcus cysts and ciliated epithelial cysts.
	(3)	Ganglionic neuromas and neurofibromas.
	(4)	Benign connective tissue tumors, including fibroleiomyomas, fibromas, chondromas, and lipomas.
(B) Malignant	(1)	Lymphosarcoma.
	(2)	Hodgkin's disease.
	(3)	Leukemic lymphoma.
	(4)	Leukosarcomatosis.
	(5)	Thymic carcinoma.

The benign mediastinal tumors are far less common than the malignant, the vast majority of which arise from either the lymph nodes or thymus.

PATHOLOGY

Lymphosarcoma.—Until Kundrat (2), in 1893, gave a clear description of this type of neoplasm as distinguished from other types, they had all been included in the large group of lymphomas. Lymphosarcoma may arise in one group of lymph nodes or in any lymphoid tissue, such as the tonsils and lymph follicles of the intestinal tract, and apparently spreads by way of the lymphatics (Boyd, 3). Lymphosarcoma may metastasize to distant organs, probably by way of the bloodstream. In the majority of cases, mediastinal lymphosarcomas arise in the anterior mediastinum, but frequently they are found in the vicinity of the thymus. For this reason, some authors believe that these tumors are often confused with the thymus.

Lymphosarcomas of the mediastinum grow rapidly and may fill the entire mediastinal space, and invade the lungs, bronchi, and other mediastinal organs.

Microscopically, lymphosarcoma has been divided into two types: (1) the lymphocytic type, which consists of a diffuse collection of small round cells with deeply staining nuclei, simulating adult lymphocytes, and also some larger cells resembling lymphoblasts. Between the cells there is a fine reticulum. (2) The reticulum cell type (Fig. 1) or reticulo-endothelial type (Boyd). This tissue shows a loose arrangement of moderately large pale cells with vesicular nucleus. This type of lymphosarcoma arises from the reticulum cells of lymph nodes or lymphoid tissue.

According to Haagensen (1), the lymphocytic type of lymphosarcoma of the mediastinum is rare, the reticulum cell or large round cell being far the more common.

Hodgkin's disease, also known as lymphogranulomatosis or lymphomalignum,

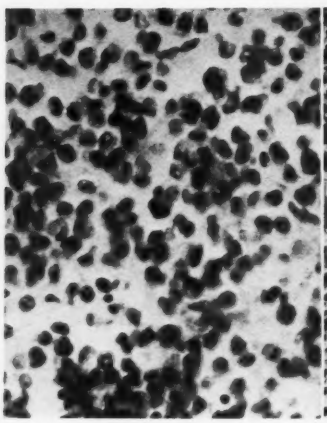

Fig. 1. Lymphosarcoma (reticulum cell type).

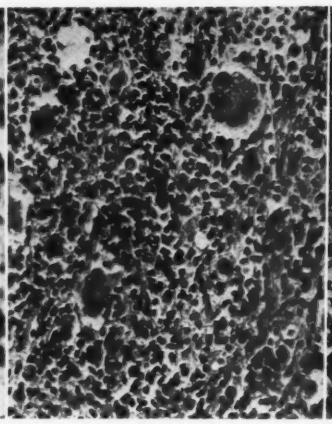

Fig. 2. Hodgkin's disease.

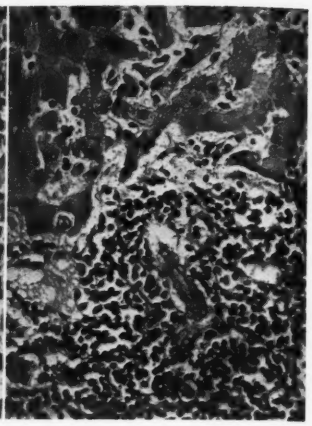

Fig. 3. Lymphatic leukemia.

was thoroughly studied by Sternberg (5) and Dorothy Reed (6). The true nature of this form of tumor is still uncertain; it is regarded by some as an infectious granuloma and by others as a true neoplasm because of its invasive tendency and other characteristics of a malignant tumor. It is, therefore, included in the group of malignant lymphomas together with lymphosarcoma and lymphatic leukemia.

A mediastinal tumor may sometimes form the only evidence of Hodgkin's disease. More frequently it involves other lymph nodes, particularly the deep cervical and other lymphoid tissues, and especially the spleen, which is usually enlarged. Other organs may also be affected, not rarely the lungs, bone marrow, liver, and skin. Wessler and Greene (7) found mediastinal involvement in all cases of Hodgkin's disease observed by them.

Ewing (4) believes that mediastinal Hodgkin's disease furnishes a large proportion of cases terminating in lymphosarcoma. In a study of more than five hundred cases, Levin (8) frequently found pathologic evidence both of Hodgkin's disease and lymphosarcoma, not only in the same patient but even in different areas of the same tumor.

Microscopically, Hodgkin's tumor (Fig. 2) consists of a hyperplasia of the reticuloendothelium. There is a reticulum in which lie a few small and large lymphocytes, plasma cells, eosinophiles, and Dorothy Reed or Sternberg giant cells.

Leukemia.—Boyd (3) defines leukemia not as a disease of the blood but as "a condition in which there is proliferation of the leukoblastic tissue either myeloid or lymphoid, as a result of which the proliferated cells may appear in the blood." He distinguishes the following three types:

(*a*) chronic myelogenous leukemia;
(*b*) chronic lymphatic leukemia;
(*c*) acute leukemia.

In the first type, the lymph nodes are only moderately enlarged and rarely acquire the proportions of the second type or chronic lymphatic leukemia, in which disease mediastinal tumors are not uncommon. Since these tumors sometimes manifest the same physical signs and symptoms as lymphosarcoma or Hodgkin's disease, it may prove difficult to distinguish them from the latter.

In chronic lymphatic leukemia, the spleen is usually enlarged; the same is true of the lymph nodes and other lymphoid tissue. There may also be leukemic infiltrations in any organ of the body, not rarely in the liver and the skin.

The microscopic picture of chronic lymphatic leukemia (Fig. 3) consists of hypertrophy of lymph follicles, which fuse with

the pulp cords to transform the entire node into diffuse lymphoid tissue.

Cooke (9) describes nine cases of acute leukemia in children, all with large mediastinal tumors. He believes that in children mediastinal tumors most commonly appear in association with acute leukemia.

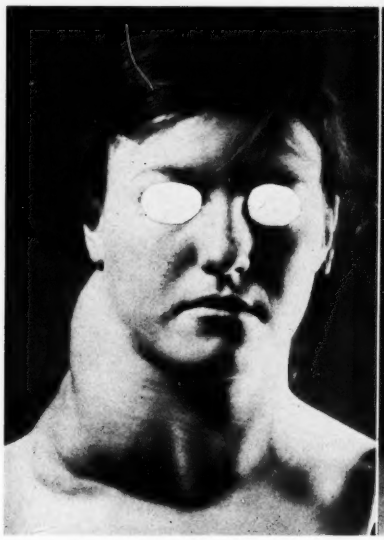

Fig. 4.

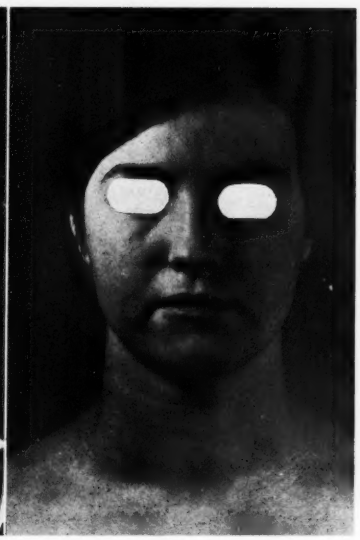

Fig. 5.

Fig. 4. Case 1. V. L., female, aged 14 years and six months. Probable diagnosis made in August, 1929, was lymphosarcoma of the cervical lymph nodes.

Fig. 5. Same case as shown in Figure 4. Roentgenogram taken in February, 1930, six months after radiation.

Some authors hold that the leukemias belong in the group of neoplastic diseases, with particularly close relationship to leukosarcoma, lymphosarcoma, and Hodgkin's disease. In 1902, Babes (10) advanced the theory of the neoplastic nature of leukemia; many authors, among them Ewing, later subscribed to this theory. Evans and Leucutia (11) report three cases of lymphosarcoma which changed into lymphatic leukemia as soon as the bone marrow became involved by foci of lymphosarcoma.

AGE AND SEX DISTRIBUTION

All three diseases appear to affect males more frequently than females, as shown by Pack and Lefevre (12) in their comprehensive survey of malignant diseases treated at the Memorial Hospital, New York, during a period of twelve years. In their cases of lymphosarcoma, 64 per cent were males, the average age of the mediastinal group being 44, and the greatest distribution of cases being between 34 and 39 years. Sixty per cent of their cases of Hodgkin's disease were males, but the patients were younger than those of the lymphosarcoma group, the majority being between 30 and 34 years. Of their leukemic patients, 72 per cent were males with an average age of 47 years. Acute leukemia is essentially a disease of childhood and youth, and is rare in adult life.

SYMPTOMATOLOGY

As already indicated in the introduction, even though a mediastinal tumor may be comparatively small, it may produce serious symptoms because of the close relationship of the various organs in the mediastinum. Since symptoms manifested by mediastinal tumors are essentially due to compression of the mediastinal organs, they will not differ greatly, whether the tumor be a

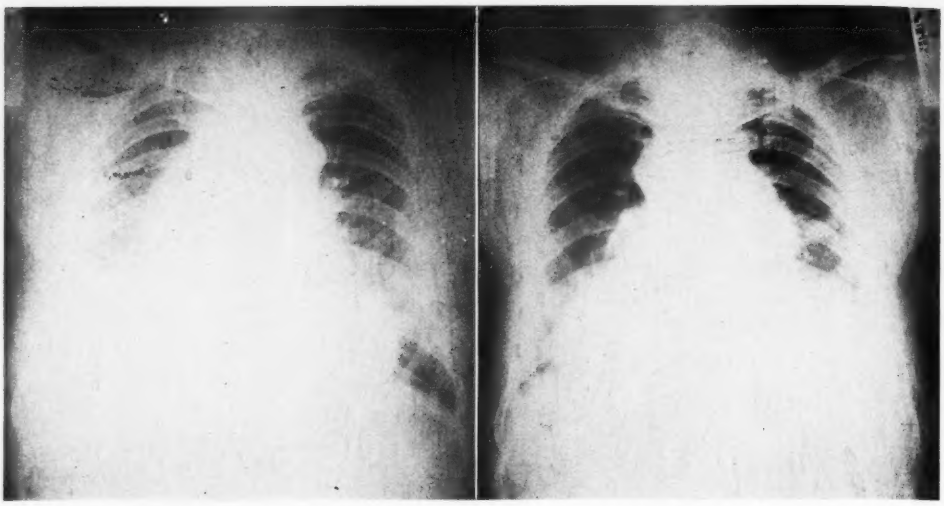

Fig. 6. Fig. 7.

Fig. 6. Case 2. M. G., male, aged 48 years. Roentgenogram was taken in March, 1932. A differential diagnosis between mediastinal tumor and aneurysm was made.

Fig. 7. Case 2. M. G., male. Roentgenogram was taken in April, 1932. There was a slight improvement following radiation, confirming the diagnosis of mediastinal tumor, probably thymoma (radioresistant).

lymphosarcoma, Hodgkin's disease, or leukemia.

The onset of all three diseases is usually insidious; the patient may be free of symptoms for a long time despite the fact that he is harboring a malignant condition. In the later stages, however, in addition to the general symptoms of weakness, pallor, and loss of weight, the outstanding complaints are pain in the chest, respiratory difficulty, cough, and dysphagia when the tumor exerts pressure on the esophagus. Pressure on the heart may cause palpitation, anginal pain, and inequality of the radial pulses. Pressure on the recurrent nerve produces hoarseness or aphonia.

Craver (13) stresses the frequency of puffiness of the eyelids and swelling of the base of the neck associated with mediastinal tumors. Pressure on the large veins produces cyanosis and edema of the face, upper thorax, and upper extremities, with enormous distention of the subcutaneous veins, especially those of the thorax.

The cough is often accompanied by profuse expectoration, sometimes blood-tinged. Hemoptysis is not uncommon, and occasionally there is pleural effusion.

The painless adenopathy which usually accompanies lymphosarcoma, Hodgkin's disease, and lymphatic leukemia is variable. It may be generalized, as in leukemia or Hodgkin's disease, or localized, as in lymphosarcoma. Pruritus or some other skin condition is not an uncommon early symptom in Hodgkin's disease.

Lymphosarcoma of the mediastinum may perforate the sternum and appear upon the chest as a tumefaction.

Patients with lymphosarcoma and lymphatic leukemia usually run a low-grade fever. In Hodgkin's disease, however, the Pel-Ebstein remittent type of fever is common, that is, there may be alternating febrile and afebrile periods for weeks and months.

The leukocyte sometimes aids in differential diagnosis; in leukemia, the white count is usually between 100,000 and 200,000 cells per cmm., 90 to 99 per cent of which are lymphocytes. In lymphosarcoma there is usually a low leukocytosis. In the early stages of Hodgkin's disease, the leukocyte count is normal; in the later stages, a polymorphonuclear leukocytosis

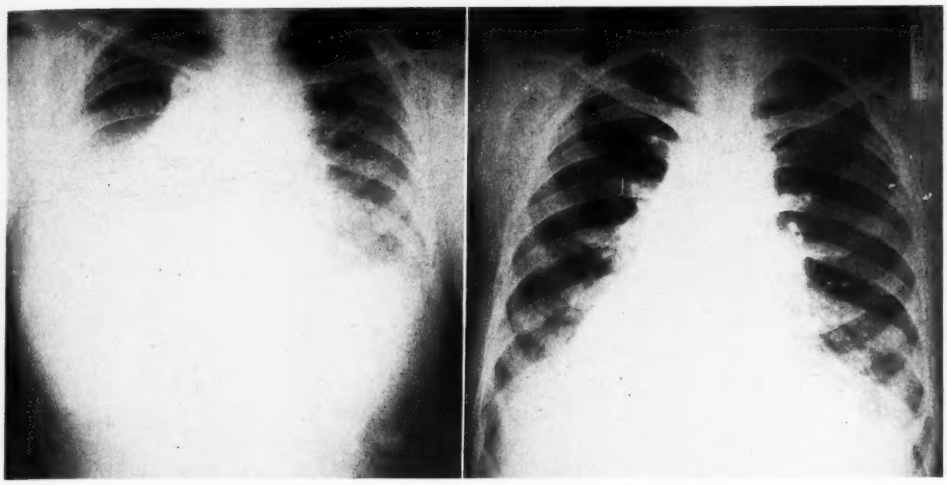

Fig. 8. Fig. 9.

Fig. 8. Case 3. J. P., female, aged 30 years. Mediastinal tumor, lymphosarcoma.
Fig. 9. Case 3, two months after radiation. There is a marked diminution in the size of the mass. There is no dyspnea.

is common. About half of these cases show evidence of eosinophilia.

DIAGNOSIS

It is often extremely difficult to make a correct diagnosis of mediastinal tumors. All the clinical evidence may point to a mediastinal neoplasm, but it is essential to know its nature in order to treat the lesion correctly. The symptoms and signs manifested by a malignant mediastinal tumor might also be presented by either a benign tumor or an aneurysm of the aorta. Pfahler (14) does not exaggerate when he states that "at times the most thorough examinations by the most expert roentgenologist combined with all other clinical evidence will not enable him to make an exact diagnosis." Of all the laboratory auxiliaries available, the roentgenologic examination and biopsy, whenever possible, are the most reliable. The shadow of an aneurysm or benign tumor will most frequently show up on the roentgen film, as distinguished from that of a malignant tumor of the types under discussion. The application of a therapeutic dose of roentgen ray is often of value in differentiating a malignant lymphoid tumor from a benign neoplasm or even some other form of malignant tumor, such as carcinoma or sarcoma (endothelioma). Lymphoid tumors are promptly reduced in size by a therapeutic dose of x-ray, thus affording relief of symptoms. Biopsy is possible only if there is superficial adenopathy.

Cutler (15) states that absence of positive roentgenologic evidence of mediastinal involvement does not necessarily indicate the absence of disease. This is demonstrated by the high autopsy percentage of involvement in mediastinal nodes.

THERAPY AND PROGNOSIS

It is generally conceded to-day that the treatment of malignant mediastinal tumors lies, not in the field of surgery, but rather in the hands of the radiologist. The methods of treatment, however, vary between roentgen ray and radium or else a combination of the two. Then again, there are various methods of treatment with the roentgen ray. Some are satisfied with results obtained from local therapy, while others prefer total irradiation. This topic, however, will be further discussed on the basis of the following cases.

Case 1. V. L., a white female, aged 14 and one-half years, was seen on Aug. 26,

1929. Two years before, a growth had been noted on the right side of her neck. During the first year, the growth increased slowly in size, but subsequently grew very rapidly. She had had the usual childhood diseases and frequent colds. A tonsillectomy was performed one and one-half years prior to my examination of the patient. The only family incidence of malignancy was a carcinoma of the cervix in the patient's grandmother.

Physical Examination.—The patient's general condition was good. There was a swelling over the left side of the neck which extended from the base of the left side of the neck and the upper border of the left clavicle to the mastoid region, measuring 42 cm. in circumference at the base, 41 cm. at mid-line, and 39 cm. at the apex; laterally, it extended from a point directly parallel to the center of the jugular notch of the manubrium to the mid-line of the vertebral column. An accentuated pulsation was noted in the left external carotid artery. Some dilation of superficial veins was present, being most marked in the lower portion of the tumor of the neck and in the left chest directly below it. Several glands measuring 2 cm. in diameter were palpable in the apex of the left side of the neck; there was none in the axillæ and the groin.

Radioscopic examination of the neck and chest demonstrated a large soft-tissue tumor in the left side of the neck and a widening of the mediastinum, probably due to enlarged hilar nodes.

As a biopsy was refused by the family, a probable diagnosis of lymphosarcoma of the cervical lymph nodes was made. The recommended therapy consisted of application of radium and x-ray treatments. On the same day, a radium element pack, 6,000 mg.-hr. (300 mg. for 50 hours), was applied to the involved area of the neck.

At the end of this treatment, two days later, the cervical mass was diminished in size. The patient was then given a series of 24 roentgen-ray treatments, over two fields (left lateral and right lateral neck), receiving 2,400 r to each area, over a period of six weeks.

When last seen, Jan. 10, 1935, the neck was normal except for a slight contraction of the skin. The patient was married, and when last reported had given birth to a healthy child.

Case 2. M. G., a white male, aged 48 years, was seen on March 7, 1932. About four weeks previously, he had suffered an excruciating pain in his right shoulder, which radiated down toward the elbow and up toward the neck. Only slight relief was afforded by the application of heat, and he was obliged to resort to sedatives to secure sleep. This severe pain lasted about a week, then subsided to begin again a few days before observation. His past and family histories were irrelevant.

On examination, the patient was found to be in good general condition, with a normal amount of adiposity and no evidence of loss of weight. The skin was soft and moist. The heart and lung sounds were apparently normal. No glands were palpable. The patient had an abnormally broad and thick neck. Radioscopic examination of the chest revealed a broadening of the mediastinum at the level of the aortic arch, and the presence of what appeared to be a small amount of fluid in the right pulmonary field. A differential diagnosis between mediastinal tumor and aneurysm could not be made. A therapeutic test of irradiation, therefore, seemed advisable. A slight improvement resulted and a clinical diagnosis of mediastinal tumor, probably lymphosarcoma or thymoma, was confirmed.

A cycle of 25 x-ray treatments of 350 r each was administered three times a week, over three anterior and four posterior fields, over an interval of two months.

During this course of irradiation, the patient also received several injections of Coley's toxins, following the administration of which there occurred rather severe local and general reactions. These reactions were accompanied by pain and swelling of the right arm. The patient received, in addition, one treatment with radium element pack (12,000 mg.-hr.) over the right anterior chest.

On April 22, 1932, about two months after institution of treatment and about a week after the completion of the cycle, roentgen-ray examination of the chest showed a retrogression of the left border of the mediastinal lesion; the right border seemed to be more distinctly outlined.

Although there had been some improvement at the beginning of irradiation, it was but temporary, and at the completion of the outlined course of therapy, severe cough and rapidly progressing general weakness developed. Marked dyspnea was present. A transfusion was recommended and administered, following which there was slight improvement in the condition of the patient.

On May 1, he was admitted to the hospital, suffering from a severe cough, an even more marked dyspnea, and an extensive edema of the face, neck, and upper extremities. Radioscopic examination made at this time revealed the outline of the mediastinal shadow to be unchanged. There was, however, a small area of homogenous opacity, suggesting the presence of fluid in the right costophrenic sinus. A consultation was arranged with Dr. Lloyd F. Craver, who suggested an aspirated biopsy, which was done. The material obtained showed only the presence of blood and fibrin; no tumor cells were found.

Several months later, the patient was readmitted to the hospital in a very poor condition. He became progressively worse and died shortly after.

Case 3. J. P., a white female, aged 30 years, who, two months before the examination, on Aug. 1, 1932, had developed attacks of a choking sensation, which were accentuated when lying down. These attacks were accompanied by a sense of pressure in the upper chest. Dyspnea had become increasingly more marked and was accompanied by severe coughing. The patient had consulted a physician who made a diagnosis of pleural effusion for which he performed a thoracentesis twice in the period of two months. The amount of fluid removed is not known. The patient stated that she had lost twelve pounds during the preceding three or four months.

Physical Examination.—The patient was in good general condition except for the dyspnea and a rather severe cough. No abnormal physical signs were found.

Radioscopic Examination.—Made Aug. 1, 1932, showed a broadening of the mediastinal shadow. There was a complete absence of illumination through the left lower lobe, apparently due to the presence of an exudate. A diagnosis of mediastinal tumor, probably lymphosarcoma, was made.

Thoracentesis for the aspiration of the fluid and deep x-ray therapy to the neoplasm were recommended.

On August 6, the chest was aspirated and 2,000 c.c. of clear green fluid was withdrawn. A series of eight x-ray treatments, 350 r each, was given, over a period of three weeks, to the anterior and posterior mediastinum.

On August 11, five days after instituting treatment, radioscopic examination showed reduction in the size of the mediastinal shadow. The left costophrenic sinus was still somewhat opaque, indicating the presence of residual exudate. Two weeks later, radioscopic examination showed a marked retrogression of the mediastinal shadow. The opacity suggesting fluid in the left costophrenic sinus was still present. On September 23, roentgenogram revealed still further diminution in size of the mediastinal shadow. The previously noted opacity in the left costophrenic sinus was no longer evident. The left diaphragm was well outlined.

The patient's general condition was markedly improved, the dyspnea was not any more evident, and there were no other symptoms.

Case 4. J. B., a white female, aged 44 years, gave a history of an injury to the anterior chest wall six years previous to the date of examination, Dec. 13, 1930. One year following this injury, after pain had been present for some time, a diagnosis of tumor of the sternum was made. The tumor was removed surgically, but recurred two years later. At that time, it

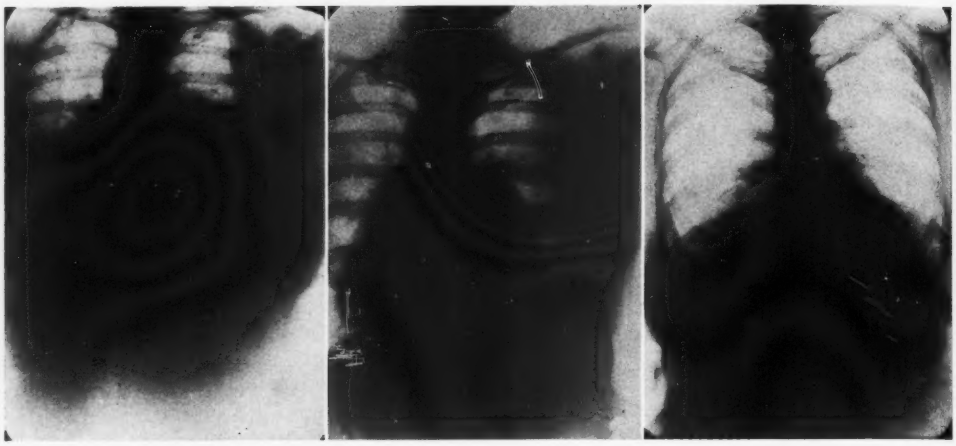

Fig. 10. Fig. 11. Fig. 12.

Fig. 10. Case 4. J. B., female, aged 44 years. Roentgenogram was taken in December, 1930. Mediastinal tumor, probably lymphosarcoma.

Fig. 11. Case 4. Roentgenogram was taken in February, 1931. There is a marked decrease in the size of the tumor mass.

Fig. 12. Case 4. Roentgenogram was taken in May, 1931. After a re-examination there was an almost complete disappearance of the mediastinal mass.

was treated by low voltage x-ray therapy. Eight months before the present observation, thoracentesis had yielded 1,400 c.c. of fluid. Pain had been severe in the region of the right breast for nearly a year. During the past few months, the patient had suffered from dyspnea, especially when lying down.

Physical Examination.—The patient's general condition was fair. Marked dyspnea was present. Pain in the right chest was severe, and there was evidence of previous irradiation in this area by low voltage and low filtration. This evidence was in the form of a crater-like destruction with an accumulation of serous discharge under a crust which could be easily removed.

Roentgen-ray examination revealed the presence of a tumor mass in the right thoracic cavity in the region of the hilum (Fig. 10). A diagnosis of mediastinal tumor was made, probably lymphosarcoma. Radiational therapy was instituted by means of external application of radium, 10,000 mg.-hr., over a period of 24 hours.

Marked improvement followed during the succeeding six months. A radiograph of the chest then revealed marked decrease in the size of the tumor mass (Fig. 11). Three x-ray treatments of 300 r each were given within one week. Due to the poor condition of the skin over the lower portion of the sternum, the posterior and lateral chest were used as ports of entry.

About a year later, recurrence developed. The patient complained of shortness of breath. Six x-ray treatments, 300 r each, were given over a period of 18 days, to the anterior and posterior mediastinum. Again marked improvement resulted.

The patient then remained in good condition for about eight months. Dyspnea, however, again developed, accompanied by generalized weakness. A thoracentesis was done by a physician two weeks before examination, and a profuse sero-sanguinous discharge persisted from the thoracentesis wound. X-ray therapy was again given, followed by marked improvement.

In May, 1931, an x-ray film of the chest showed a decrease in the size of the mediastinal mass (Fig. 12).

On Nov. 26, 1932, the patient returned for re-examination, complaining of nausea and difficulty in retaining food. The opening on the chest began to break up. Radia-

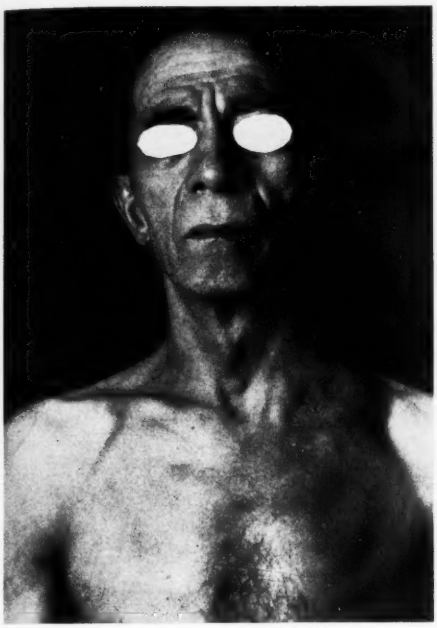

Fig. 13. Case 5. S. G., male, aged 58 years. Roentgenogram was taken on April 11, 1932. A case of Hodgkin's disease.

tion treatment was not indicated, due to the poor condition of the surrounding tissue. The patient was referred to a local physician for symptomatic treatment. She was admitted to Wyckoff Heights in March, 1933, and expired on March 18, 1933.

COMMENT

In these four cases of lymphosarcoma involving the mediastinum, irradiation therapy was followed by marked diminution in size of the tumors, as proved by radioscopic examination, accompanied by improvement of the condition. The pregnancy, which was a normal one and terminated with the birth of a healthy child, apparently did not aggravate the patient's condition, which feature may be of importance in considering the relationship of pregnancy to the physiology of malignant neoplasms. After treatment by radium pack and roentgen ray, more than six years ago, the patient's neck became normal in size and there has been no recurrence.

In Case 2, after a cycle of 25 roentgen-ray treatments over a period of two months, there was regression of the mediastinal tumor and some improvement in the general condition, which, however, was only temporary. Several months later, the patient's condition became aggravated and death ensued. In view of the fact that the tumor did not respond well to irradiation, it is highly probable that the neoplasm was a thymoma and not a reticulum-cell lymphosarcoma.

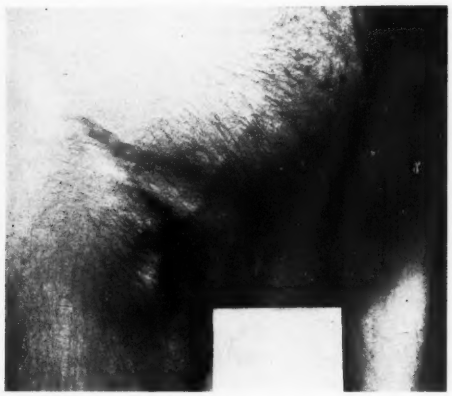

Fig. 14. Case 5. Roentgenogram was taken on April 11, 1932. A case of Hodgkin's disease.

In Case 3, the eight roentgen-ray treatments over a period of three weeks were followed by diminution in the size of the mediastinal mass, accompanied by marked relief of the symptoms. To-day, after four years, the patient is well and has had no recurrence.

Case 4, when first seen by me more than five years ago, had already received low-voltage roentgen-ray therapy elsewhere, with apparently little benefit. Radium pack application brought diminution in the size of the mediastinal shadow, and the tumor responded even more to roentgen irradiation. However, there was recurrence one year later, and again roentgen-ray therapy brought improvement for about eight months. The patient had been able to attend to her work as a housewife for this period. Prolongation of life was established for a total of eight years since the onset of the disease.

Case 5. S. G., a white male, aged 58

years, was seen on April 11, 1932 (Figs. 13 and 14). Physical examination revealed an emaciated patient, with a decidedly protruding abdomen. There were numerous glands in the left base of the neck, forming a puffiness of the supraclavicular area, with disappearance of the normal demarcation of the supraclavicular space. There were several glands in the left axilla but none was palpable in the right. The liver was felt about three fingers' breadth below the costal margin. The spleen was not palpable. Glands were palpable in both inguinal regions, more on the right than on the left.

Blood Count.—Hemoglobin, 55 per cent; red blood cells 3,200,000; white blood cells, 24,000; lymphocytes, 25 per cent; small lymphocytes, 10 per cent; polymorphonuclears, 55 per cent; basophils, 2 per cent; eosinophils, 10 per cent, and transitionals, three per cent.

X-ray therapy was instituted over a period of ten weeks, the anterior left supraclavicular area receiving 1,400 r, and the axilla, mediastinal, and inguinal glands receiving 700 r each.

During these treatments, the patient's red blood count dropped to 2,600,000, and a transfusion was therefore given (500 c.c. of blood). Marked improvement was noted and the treatments were resumed. The patient was discharged but returned one month later complaining of pain in the stomach and the left anterior inguinal region. The liver was found to be enlarged, and two treatments of 200 r each were given to it and to the anterior abdomen; the open field was given 350 r, within one week. X-ray examination of the chest at this time revealed a broadening of the mediastinum and entire opacity of the apices, fusing with the soft tissue of the neck. There were increased markings of the hila. A diagnosis of Hodgkin's disease was made.

The patient was relieved of symptoms for about one month, and after becoming progressively worse, exitus was reported by the family physician on October 3,

Case 6. L. M., a white male, 41 years of age, complained of pain in the hips and the long bones of the legs. His family history was irrelevant. He dated his present illness to three years before when he noticed a swelling in the neck. He was given x-ray therapy at different intervals, with improvement in his condition.

When first seen by me on Aug. 7, 1935, there was a swelling present on both sides of the neck, but no distinct glands could be palpated. There was fullness in the right superclavicular region and some fibrosis in the left supraclavicular region. Small glands were palpable in both axillæ, and a few small glands were felt in the left groin; there was none in the right inguinal area.

Radioscopic examination of the chest revealed a broadening of the middle third of the mediastinum and increased marking of both hila. The pelvis showed some bone changes in the lumbosacral junction of the fifth vertebra.

Blood Count.—Hemoglobin, 80 per cent; erythrocytes 2,800,000; white blood cells, 14,000.

The diagnosis of Hodgkin's disease was made and therapy was immediately instituted, as follows: A radium pack was applied to the fifth lumbar area for 6,000 mg.-hr., and five x-ray treatments, 100 r each treatment, were given over the entire body, alternating anterior and posterior, on consecutive days, at a distance of 120 centimeters. This was combined with 15 local x-ray treatments daily, at 50 cm. distance, to the glandular areas.

One month later, the patient received six more deep x-ray treatments over the cervical and mediastinal gland areas, one erythema to each field.

Following the second therapy, another blood count was done on September 18, which showed hemoglobin, 70 per cent; red blood cells, 4,000,000, and white blood cells, 12,000. Up to date, the patient has been reported in fair condition. A more recent blood count shows no appreciable change.

COMMENT

These two cases of Hodgkin's disease differed considerably in their response to irradiation. Case 5, over a period of ten

weeks, was given 16 roentgen-ray treatments of 350 r each to the left supraclavicular region, to the axillæ, anterior and posterior mediastinum, and to the inguinal areas, in addition to 200 r to the liver and anterior abdomen. Improvement followed for one month, but the patient went rapidly downhill and died four months after irradiation.

In Case 6, therapy was commenced with radium over the lumbar region for the bone changes. Entire body roentgen-ray treatment was administered on five consecutive days, 100 r per field at a distance of 120 centimeters. This therapy was combined with 15 local roentgen-ray treatments of 350 r each, over 15 consecutive days. The patient's condition has improved markedly.

Case 7. H. C., a white male, aged 52 years, had had enlarged lymph nodes of the cervical and axillary regions for a period of several months preceding examination on May 23, 1932. He complained of frequent asthmatic attacks, and a slight cough with occasional bloody mucus in his sputum. His family and previous histories were negative.

When examined, the patient was markedly dyspneic. There were several enlarged glands in both axillary regions, but more numerous and larger in the left. There were several small glands in the right cervical region; none was palpable in the left. There was a protrusion of the chest wall on the right side. Breath sound were accentuated on the left side and decreased on the right, being practically absent over the upper right lobe. Sputum demonstrated a "prune-juice" appearance. Roentgen-ray examination revealed the presence of an extensive process involving the superior mediastinum and the upper right portion of the chest. The illumination of the upper right pulmonary field was practically absent. The left hemithorax was well illuminated. Both costophrenic sinuses were clear. His blood count showed hemoglobin, 75 per cent; red blood cells, 5,100,000; white blood cells 86,000; small lymphocytes, 80 per cent, the rest polymorphonuclears.

A tentative diagnosis of leukemia was made. X-ray treatments and the application of radium were recommended, and instituted on May 23, 1932, as follows: Treatment was given three times a week, for a period of two months, over the mediastinum, axillæ, and inguinal glands, 1,200 r total to each field, in divided technic.

During this cycle of treatment, one radium element pack was applied to the anterior right supraclavicular area, 2,800 milligram-hours.

In the course of treatment, the patient's blood count came down to 30,000, but the glandular enlargements were not diminished in size.

Case 8. I. N., a white male, aged 63 years, complained of difficulty in breathing, loss of weight, and weakness due to inanition because of difficulty in swallowing. For one week he had noticed a swelling on the right side of the neck, below the ear. He had been well until one year previously, when he began to lose weight.

On examination, July 2, 1935, glands could be palpated in both axillæ and groins. There was a large swelling, about the size of a fist, in the right side of the neck. There were also several palpable glands in the left side of the neck. Both tonsils were about the size of a walnut, and irregular in shape, making it impossible for the patient to take food, and impeding breathing. The liver was felt about four fingers' breadth below the costal margin.

X-ray examination of the chest showed no evidence of gross abnormalities in the lungs, pleura, or diaphragm.

The blood examination revealed: hemoglobin, 78 per cent; red blood cells, 5,5,00-000; white blood cells, 182,400.

A diagnosis of chronic lymphatic leukemia was made, and deep roentgen-ray therapy was immediately instituted. The right lateral neck received 1,500 r, the spleen 2,100 r, and the other cervical and axillary glands 700 r each of deep x-ray therapy for a period of five weeks. The patient was given a rest interval from August 10 to September 10; then treatment was resumed as follows: the cervical glands received a total of 1,300 r on each side, and

the posterior entire trunk 50 r on each, at 120 cm. distance.

The blood picture on Dec. 15, 1935, showed 78 per cent hemoglobin; 4,100,000 red blood cells; 29,000 white blood cells; 90 per cent lymphocytes; 10 per cent polymorphonuclears. The patient feels well and has gained eight pounds in weight.

The glandular involvements were reduced in size. The tonsils, especially, have responded very well to radiation, and have come down less than one-third of their former size.

Case 9. R. W., a white male, aged 49 years, was examined on August 21, 1931. The family history was negative. The patient stated that he had always been in good health until about ten years previously, when he suffered an attack of what he termed "septic poisoning." This illness lasted for four years, and necessitated several operations on localized abscesses. During this time, he was also operated on for strangulated hernia. The six years following were uneventful, and the patient was comparatively well until about six months prior to the present examination, when he noticed an enlargement of the lymph nodes of the cervical, axillary, and inguinal regions. He complained chiefly of great fatigue and generalized weakness which had recently become more marked.

On examination, the patient was found to be in fair general condition. There was a generalized adenopathy present, being most marked in the axillæ and the inguinal regions. There were several enlarged glands, each about the size of a walnut, in the posterior triangle of the neck and in the region above the middle portion of the clavicle. In the right axilla there were two large glands and several approximating in size those of the cervical region. In the left axilla there was one gland about the size of the smaller glands in the right axilla and neck. In the right groin there was a mass of nodes measuring 12 × 5 cm., and in the left groin there was a corresponding mass measuring 11 × 5 centimeters. In the left abdomen, just below the costal margin, there was slight rigidity, and an indefinite mass probably due to an enlarged spleen.

The blood Wassermann was negative.

Blood count was as follows: erythrocytes, 4,125,000; leukocytes, 18,000; hemoglobin, 80 per cent. The differential count was: lymphocytes, 52 per cent; large mononuclear leukocytes, 16 per cent; polymorphonuclear, 30 per cent; eosinophils, 2 per cent.

The roentgen-ray examination of the chest revealed moderate enlargement of the mediastinum, due probably to enlarged mediastinal glands. No abnormalities, otherwise, were noted in the lungs, pleura, or diaphragm.

A diagnosis was made of lymphatic leukemia with involvement of the mediastinal glands. Radiotherapy was recommended, to be administered to the involved areas of the enlarged lymph nodes, spleen, and to the long bones. A cycle of 15 treatments was administered over a period of about four weeks, averaging three treatments weekly, 300 r each treatment, radiating the cervical, axillary, and inguinal areas, and the spleen (two fields), giving 700 r to each field.

In the first few weeks after institution of treatment, there was marked improvement in both the local and general condition of the patient. The cervical glands had practically disappeared, the glands in the left axilla and inguinal regions were only slightly palpable, and the glands in the right axilla and groin were greatly diminished in size. The patient had begun to gain weight.

About two months after institution of treatment, the patient returned complaining of loss of weight, and an extremely marked general weakness. The abdomen was greatly enlarged, and a well-defined mass of retroperitoneal lymph nodes could be felt in the region of the umbilicus.

Blood Count.—Erythrocytes 2,500,000; leukocytes, 40,000; hemoglobin, 50 per cent. The differential count was: large mononuclear leukocytes, 60 per cent; lymphocytes, 30 per cent; polymorphonu-

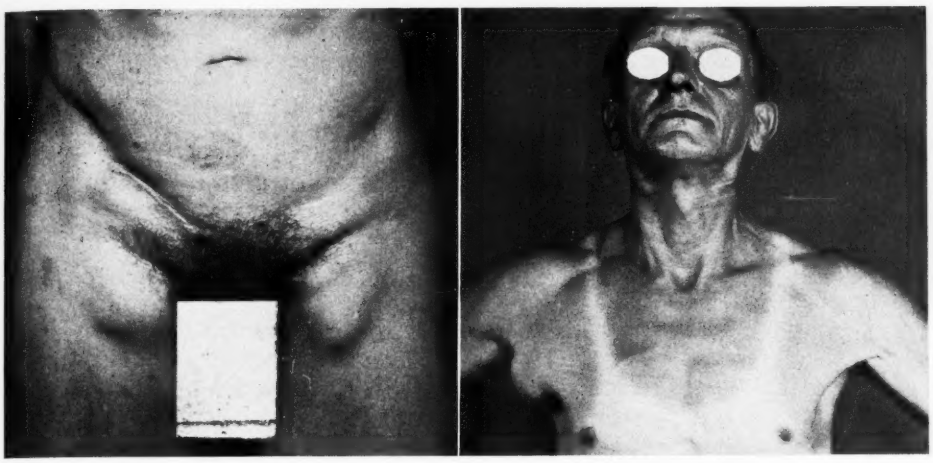

Fig. 15-*A*. Fig. 15-*B*.

Fig. 15-*A*. Case 9. R. W., male, aged 49 years. A diagnosis of lymphatic leukemia was made on Aug. 21, 1931.

Fig. 15-*B*. Case 9. A diagnosis of lymphatic leukemia was made on Aug. 21, 1931.

clear leukocytes, 1 per cent; transitional cells, 2 per cent.

A second cycle of x-ray treatments was given from October 12 to November 28, directed this time to the abdomen, spleen, and long bones. Sixteen treatments were given, 250 r each, averaging a total of 500 r per field.

Two weeks after the completion of the second cycle, the patient was admitted to the Flower Hospital. His general condition was very poor. He was very weak, and complained of nausea and vomiting and of a severe cough, with hemoptysis. He was given a transfusion of 800 c.c. of blood. Some improvement followed for a short time. Several weeks later, he had severe hemoptysis and also severe bleeding from the gums, and died on Jan. 20, 1932, more than five months after the institution of treatment.

Case 10. J. Z., a white female, married, aged 46 years, complained of pain over the splenic area and in the legs. The family history was negative. The patient had been well until 14 months prior to the present examination, when she had pain, and felt a swelling in the left upper quadrant. The year before, she had been sent to a local hospital where she received x-ray therapy, following which the swelling regressed, and the patient felt better for several months. For a few weeks prior to the present examination, the patient had suffered severe pain in the splenic area and in the legs. She had frequent headaches and was troubled with insomnia. She had lost 15 pounds in weight. On examination, an enlarged spleen could be felt four fingers' breadth below the costal margin. No lymph nodes could be felt.

Blood Picture.—Hemoglobin, 55 per cent; red blood cells, 3,250,000; white blood cells, 52,000; large lymphocytes, 29 per cent; small lymphocytes, 10 per cent; myelocytes, 40 per cent; polymorphonuclears, 18 per cent; eosinophils, 1 per cent; transitionals, 2 per cent.

On the basis of the clinical findings, a diagnosis of leukemia was made, and radiotherapy was immediately instituted over the entire body, anterior and posterior, 50 r each, 120 cm. distance, within one week.

On August 31, after two treatments, the white blood count was 58,000.

On September 1, a radium pack was applied to the spleen, 5,400 mg.-hr., within 27 hours.

On September 4, the blood picture was as follows: hemoglobin, 45 per cent; red

blood cells, 2,600,000; white blood cells, 24,000; polymorphonuclears, 51 per cent; small lymphocytes, 32 per cent; large lymphocytes, 12 per cent; eosinophils, 1 per cent; transitionals, 4 per cent.

On September 5, the patient was given a blood transfusion of 500 cubic centimeters. She was discharged from the hospital, and died on October 11, six weeks later.

COMMENT

All these four cases of chronic lymphatic leukemia were in an advanced stage of the disease. *Case 7* received 24 roentgen-ray treatments of 300 r per dose, during a period of eight weeks, also a radium pack to the right anterior supraclavicular region. The white blood count came down from 86,000 to 30,000 following this therapy. The lymph nodes, however, did not markedly decrease in size.

Case 8. Over a period of five weeks, this patient was given a total irradiation of 5,700 r to the neck, spleen, and axillæ. Following a rest period of four weeks, he received 2,600 r to the neck, in addition to two treatments over the posterior trunk, of 50 r, at a distance of 120 centimeters. The white count subsequently decreased from 182,400 to 29,000. The patient feels well and has gained in weight. The lymph nodes have markedly diminished in size. The tonsils especially have responded well to therapy, decreasing to less than one-third of their former size.

Case 9. During a period of four weeks, this patient received 15 treatments, totalling 4,500 r, to the cervical, axillary, and inguinal regions and to the spleen. These were followed by improvement in the patient's general condition, and a gain in weight. However, two months after institution of treatment, there was recurrence of symptoms, and a retroperitoneal mass was felt. Sixteen treatments were administered, making a total of 3,500 r to the spleen, axillæ, cervical and inguinal regions, and long bones. The patient showed little improvement, and died five months later.

Case 10. This patient, over a period of five days, was given an entire body irradiation of 50 r per field at 120 cm. distance. A radium pack was applied over the spleen, resulting in a diminished white count from 52,000 to 24,000. The patient nevertheless ran a downhill course, and died six weeks later.

THERAPY DISCUSSION

As already indicated, radiotherapy is the only satisfactory treatment for malignant mediastinal tumors. The efficacy of irradiation on lymphoid tumors is due to the fact that the latter are extremely radiosensitive. To quote Ewing (16): "The lymphoid tumors, which on account of rapid multiplication of cells, loose structure, and active metabolism, are among the most sensitive of tumors. . ." He also stresses that these tumors respond best to radiotherapy in patients who are in good general condition. Thymomas, however, form an exception since they are mostly radioresistant, as exemplified by *Case 2*. Desjardins (17) finds that the radiosensitivity of lymphosarcoma is slightly greater than that of Hodgkin's disease. He emphasizes the fact that lymphoid cells, while extremely sensitive at first, generally tend to lose their sensitiveness after repeated treatment until finally they fail to respond at all. This may be due to a gradual replacement of the lymphoid elements by connective tissue or to the possibility that the cells acquire increased resistance to the effect of the rays.

Of particular interest are the changes and development in the roentgen-ray technic for treatment of all three types of tumor under discussion, *viz.*, lymphosarcoma, Hodgkin's disease, and chronic lymphatic leukemia. The pioneers worked with low voltage, which subsequent radiologists have gradually increased to the present high voltage. At first, massive doses were administered, which frequently caused disastrous results. The vast destruction of tissue resulted in fatal toxic absorption, and, with regard to the mediastinum, the resulting edema produced pressure on the vital organs. These events led to fractionization of the dose. Chaoul and Lange (18)

obtained satisfactory results from small and frequent doses.

With the increased number of autopsies performed on patients who had died from the diseases under discussion, and with better clinical knowledge of these diseases, it became apparent that in lymphosarcoma, Hodgkin's disease, and leukemia there are more and larger involved areas than are clinically suspected. Therefore, it was felt that it was not sufficient to irradiate the clinically confirmed areas only, but that the suspicious lesions should also be similarly treated. Dessauer (19) and Wetterer (20) proposed total irradiation of the body. Teschendorf (21) used teleroentgentherapy or total irradiation, with good results in cases of chronic leukemia and Hodgkin's disease which had become refractory to local irradiation. The method of teleroentgentherapy merely requires that the roentgen tube be kept at a certain distance from the patient, usually 1.5 to 2 meters, in order that the rays may include all or a large area of the patient's body. Gilbert and Babaiantz (22) have elaborated a simple and practical technic for teleroentgentherapy, as shown in Figure 16.

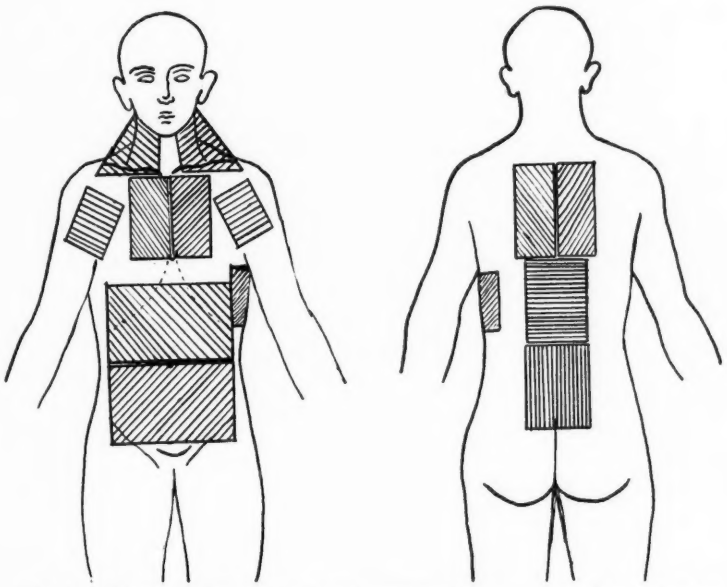

Fig. 16. Diagram of a technic for teleroentgentherapy. Reproduced from an article by Gilbert and Babaiantz with the permission of the authors.

Heublein (23) believed that in order to take advantage of the varying times of mitoses in the tumor cells, total irradiation should be of low intensity, so that it might be given continuously over a comparatively long time. He devised a roentgen-ray therapy ward in which it was possible to administer continuous irradiation to four patients at a time. Behind one wall of the room a Coolidge tube was placed near the ceiling so that the roentgen rays emanating from the tube could reach the patients in all four beds of the ward. His method of continuous irradiation proved of value in radiosensitive tumors, but of little benefit in the resistant types.

According to Cottenot and Sluys (24), teleroentgentherapy is particularly indicated in the neoplastic conditions of the blood and diseases characterized by increased hematopoietic function (polycythemia). They have thus treated advanced cases of lymphosarcoma, Hodgkin's disease, and leukemia with considerable, even

though transitory, improvement, and in many instances were able to prolong life. In treating his cases of lymphosarcoma, Cutler (15) not only irradiates the lesions that are clinically evident, but also all lymph nodes which do not show clinical evidence of disease, but which are regarded as potentially invaded. His patients receive daily irradiation for four of five weeks. He states that in the generalized form of lymphosarcoma, the disease may sometimes be controlled for several years.

In entire body irradiation, Edwards (25) uses 200 kv., 30 ma., with 131 cm. distance. Four fields cover one side of the entire body, from the top of the head to the soles of the feet, administering 25 r to each field. Recently Langer (26) has advocated irradiation of the entire vegetative nervous system, on the theory that hematopoietic lesions are influenced by the quieting effect of irradiation of an "over-irritated vegetative nervous system." He argues that Gilbert's charts for teleroentgentherapy cover practically the entire ganglia of the vegetative nervous system, thereby explaining the beneficial effects of teleroentgentherapy.

Of the cases reported in this paper, three of the four cases of lymphosarcoma were treated with radium and roentgen-ray irradiation. The radium, in doses varying between 6,000 and 12,000 mg.-hr., was applied to the area showing the greatest involvement. The neoplastic masses subsequently showed rapid diminution in size. This was followed by local roentgen-ray therapy to the various enlarged lymph nodes, in doses not varied according to the condition of the patient, but usually 350 r per treatment. The factors were as follows: 180 kv., 4 ma., at a distance of 50 cm., and filtration through 0.5 Cu +1 mm. Al. The case that did not receive a radium pack responded so well to the roentgen-ray therapy that radium was considered unnecessary.

One case of Hodgkin's disease was treated with a single application of radium, 6,000 mg.-hr., and local roentgen-ray therapy, in addition to entire body irradiation (teleroentgentherapy), receiving five treatments of 100 r each at a distance of 120 centimeters. Some of the chronic lymphatic leukemia cases were similarly treated with radium applied to the most involved area, in addition to local roentgen-ray irradiation and teleroentgenotherapy. In entire body irradiation, the dosage administered was 50 r per field at a distance of 120 cm., the factors being 180 kv., 4 ma., and filtration through 0.5 Cu × 1 mm. Al.

Since lymphosarcoma, Hodgkin's disease, and leukemia are malignant diseases, the mode of therapy should be intensive and extensive if any benefit is to be derived by the patient. Neither radium alone, local deep roentgen-ray therapy by itself, nor entire body irradiation without other therapy will prove sufficient. Only a combination of all three forms of administration of irridation will give the most satisfactory results in the majority of cases.

667 Madison Ave.

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THE CONSTRUCTION OF ROENTGENKYMOGRAPHS AND KYMOSCOPES

By WENDELL G. SCOTT, A.B., M.D., *and* SHERWOOD MOORE, M.D., *St. Louis, Missouri*

From the Edward Mallinckrodt Institute of Radiology, Washington University School of Medicine, St. Louis

THE widespread interest in the roentgenkymograph, and the fact that the apparatus has only recently become commercially available, lead us to describe a kymograph devised for the Edward Mallinckrodt Institute of Radiology. The roentgenkymograph is an apparatus designed to record the functional movements of an organ or structure on a single x-ray film. The kymograph records simultaneously the movements of multiple small points on the border of the heart or any other structure radiographed. The points are usually spaced 12 mm. apart and correspond in area to the width of the slit in the grid, namely, 0.4 millimeter. The grid is a large sheet of lead, one-sixteenth of an inch thick, in which horizontal slits are cut (Fig. 1). In using the apparatus for cardiac kymography, the patient's chest is placed in contact with the grid in the postero-anterior position (Fig. 2). The radiographic tube is behind the patient at a 70 cm. target-film distance and during a single continuous exposure of one and one-half seconds, the x-ray film is moved downward[1] behind the fixed grid over a distance slightly less than the grid spacing—actually 11 millimeters. Therefore, between every 11 mm. of exposed film there is 1 mm. of white, unexposed film which divides the kymogram[2] into frames. With the slits in the horizontal position, only the lateral expanding and the medial contracting motions of the heart are accurately and clearly recorded. Each frame is thus a record in wave form of these movements at a single point 0.4 mm. wide on the heart border. Movements of the esophagus, diaphragm, thorax, and stomach can also be studied by this method. A detailed discussion of the principles, technic, interpretation, and clinical application of kymography is given in another publication.[3]

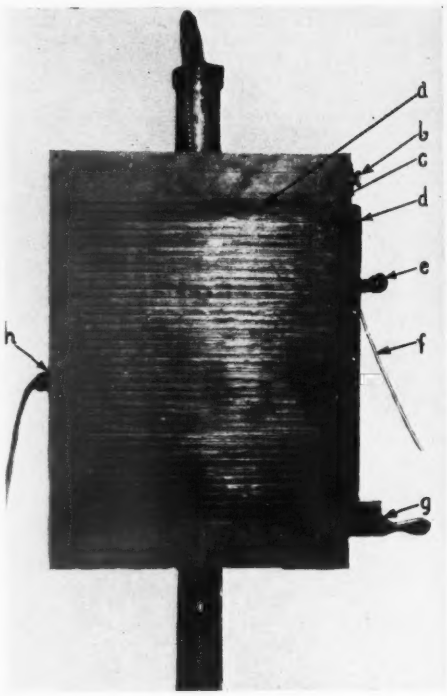

Fig. 1. Front view of kymograph, showing detail of interchangeable lead grid. (*a*) Slit 0.4 mm. wide; (*b*) adjustable timer control for Potter-Bucky pump; (*c*) 12 mm. space between slits; (*d*) cassette; (*e*) cocking lever of Potter-Bucky pump; (*f*) release cord for Potter-Bucky pump; (*g*) cassette holder; (*h*) x-ray contact plug.

The basic principle of roentgenkymography was first applied to a Polish physiologist, Sabat,[4] in 1911. In 1912, Gott and

[1] The film is moved downward for the purpose of standardizing the procedure.

[2] Kymogram, the name given to the film exposed by the kymographic method.

[3] Scott, Wendell G., and Moore, Sherwood: Roentgenkymography: Its Clinical and Physiological Value in the Study of Heart Disease. (In process of publication.)

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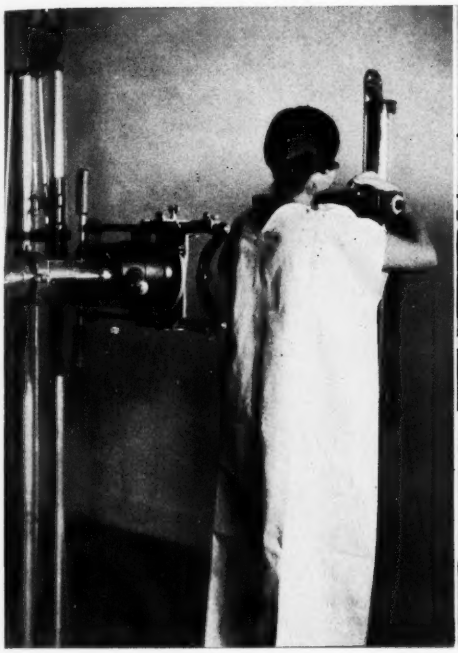

Fig. 2.

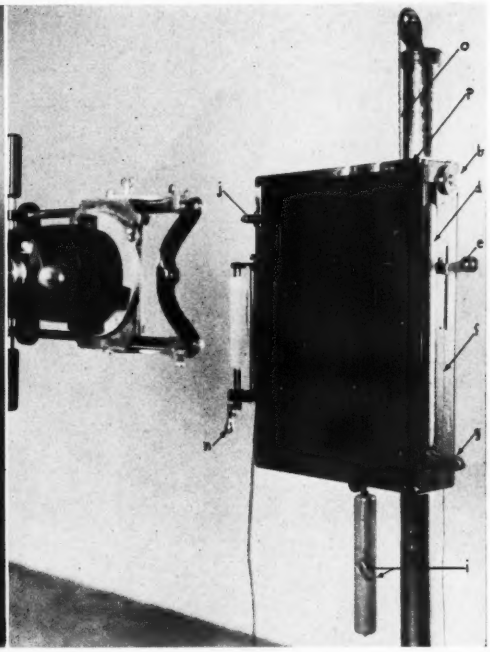

Fig. 3.

Fig. 2. Patient in position for taking the usual cardiac kymogram. The large cone used on the tube carriage is not shown.

Fig. 3. This figure illustrates the details of construction of the kymograph. (*i*) Ring to support weight to compensate for cassette when recording vertical movements as the cassette is moved horizontally; (*j*) Jaquet graphic chronometer clock with an opaque marker; (*n*) immobilizing device; (*o*) vertical adjustment chain; (*p*) brass frame permitting the use of interchangeable grids.

Rosenthal[5] made a similar apparatus and reported on its use. In 1916, Crane[6] and, in 1922, Knox[7] also built kymographs. These early instruments utilized from one to four slits in the grid, making it possible to record only that number of points on the heart's border. This limited the usefulness of the method greatly, and furthermore, the lack of x-ray tubes of sufficient capacity produced unconvincing radiograms.

Pleikart Stumpf[8] is responsible for the present-day kymograph. In 1928 he introduced a grid with multiple slits, sufficient in number to record the outline of the structure radiographed, usually the heart. By 1931 he had perfected the equipment[9] and published a description of it. Hirsch[10] reported on the requirements of a proper kymograph but did not describe the construction.

Johnson[11] was the first to describe in American literature the detailed construction of a kymograph. He used a mortised

[5] Gott, Theodor, and Rosenthal, Joseph: Ueber ein Verfahren zur Darstellung der Herzbewegung mitters Rontgenstrahlen (Rontgenkymographie). Munchen. med. Wchnschr., September, 1912, **59,** 2033–2035.

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wood frame, an oil-cylinder door-closer for regulating the speed of the film, and strips of lead glued on a board as the grid. This is an ingenious and inexpensive instrument.

front panel of the diaphragm was replaced with a slit grid similar to Johnson's.

The requirements necessary for the ideal kymograph are numerous:

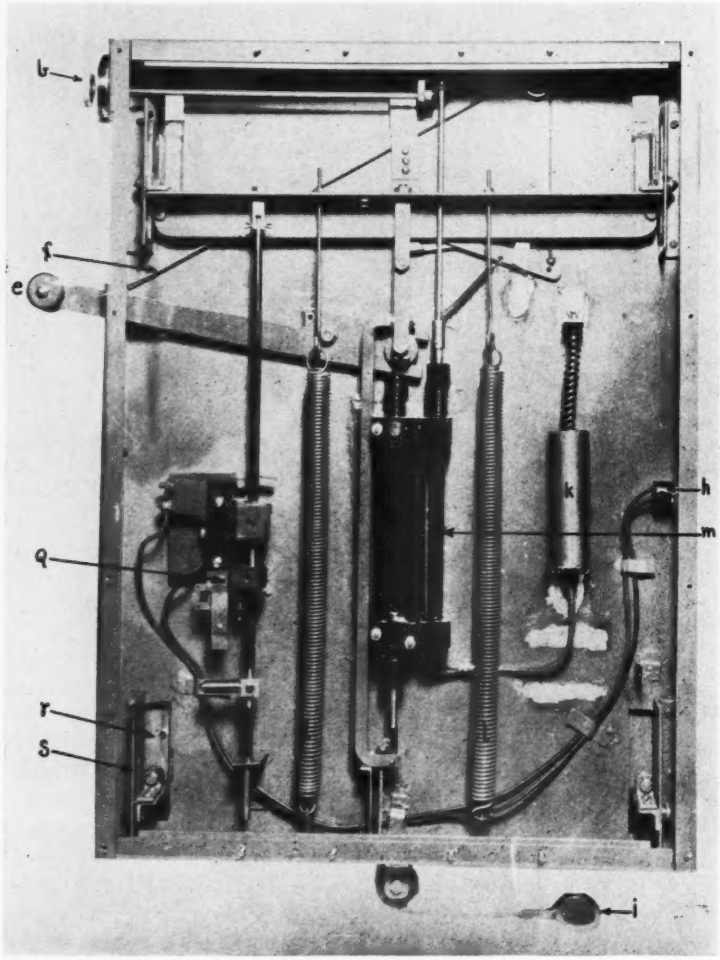

Fig. 4. Back view of kymograph after removal of outer casing to show the mechanical details. (*k*) Siphon; (*l*) tension springs; (*m*) Potter-Bucky oil pump; (*q*) x-ray exposure switch—contacts closed by the downward movement of the cassette frame; (*r*) back of cassette frame; (*s*) guide rails for cassette frame.

Van Buskirk[12] constructed a kymograph by removing the grid from an old Potter-Bucky diaphragm and replacing it with a suitable frame for holding the cassette. The

(1) The apparatus must be simple, sturdy, mobile, and inexpensive.

(2) The slits in the grid should be close together in order to record as many points as possible on the border of the heart or other structure, and yet be sufficiently far apart so that in the case of the heart, at

[12] Van Buskirk, E. M.: Roentgenkymographic Studies of Aortic Heart Disease. Jour. Indiana St. Med. Assn., November, 1935, **28**, 592–594.

least one complete cardiac cycle will be recorded.

(3) The slits must be accurately spaced, of uniform width, and absolutely parallel. Means should be provided for varying the spacing of the slits either by having interchangeable grids of 6 mm. (for very fast motion), 12 mm. (excellent for heart studies), and 18 mm. (for diaphragm, stomach, and slow movements), or utilizing a mechanism for closing or opening additional interposed slits. The borders of the slits must be beveled to conform with the arc of a 70 cm. radius.

(4) The slits should be very narrow in order that the exposure of each point on the structure be as short as possible. This factor insures sharply and clearly delineated waves.

(5) The slower the film moves, the more cardiac cycles will be recorded in each frame and the more restricted are the individual waves. This is undesirable because the wave form is intricate and should be spread over several millimeters of film to permit a detailed analysis; this requires that the film travel with fair rapidity and at a uniform rate.

(6) The recording of widely different types of motion, *e.g.*, the heart, diaphragm, gastric peristalsis, etc., demands an adjustment for regulating the speed of movement of the film. To record fast motion the film must move rapidly, while for slow movements the film should travel slowly.

(7) The kymograph should be constructed so that either the film or grid is movable while the other remains stationary. By this arrangement it is possible to produce both the "Stufenkymogram" of Stumpf, the "step-kymogram" (in which the film moves and records the movements of the same points on the heart border), or the "Flackenkymogram" or "Surface kymogram" (in which the grid moves and each wave is a record of many consecutive points on the heart border). In the "step-kymogram" each frame is the record of the movements of the same point and is therefore more accurate for the study of individual waves. In the surface kymogram

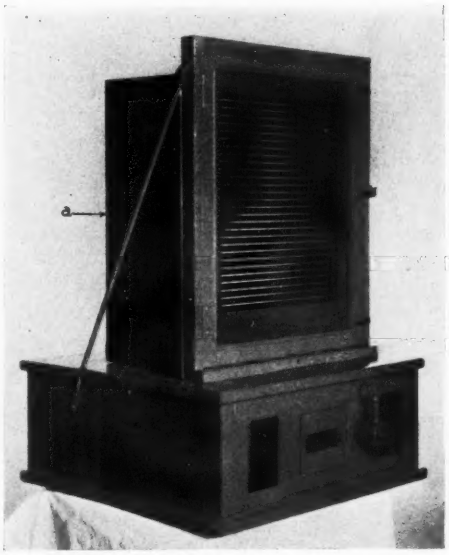

Fig. 5. Roentgen kymoscope with the grid door closed and illuminating box (*a*) in place.

the outline of the heart is more accurately reproduced and the ribs, lungs, and diaphragm appear as they do on the teleoroentgenogram. Unfortunately, the waves are not as clearly defined, as each wave is the record of numerous consecutive points instead of the same one.

(8) A clock timer with an opaque limb extending over a portion of the film to be exposed graduated in one-third or one-fourth of a second interval should be attached to the kymograph in order to produce a time record on the film. This greatly facilitates the interpretation of time occurrence of various movements.

(9) A mechanism is necessary for rotating the kymograph 90°, so that the grids can be placed in the vertical plane for recording vertical movement or tilted in any plane to bring the slits at right-angles to the heart border. Only movement occurring at right-angles to the slits can be fully and accurately recorded.

(10) A long target-film distance is desirable, but this necessitates higher voltages and consequently tubes with larger focal spots. Since a detailed reproduction of the complex movements is the first objective,

we consider it better to use a shorter target-film distance which slightly exaggerates the movements and permits the use of a tube with a smaller focal spot.

stop after the film had travelled the distance between the slits in any grid. Figure 4 is a photograph of the mechanism of the kymograph.

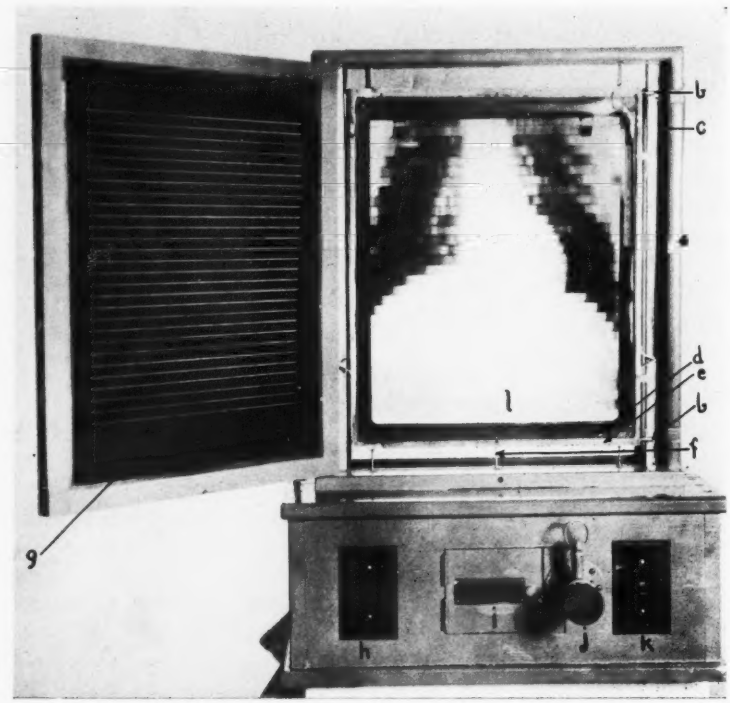

Fig. 6. Front view of kymoscope with grid door open; (*b*) tension hinge for fastening kymogram into frame; (*c*) contraction springs responsible for quick upward return of film; (*d*) inside wood frame; (*e*) outside frame for holding kymogram; (*f*) actuating rod of frame; (*g*) grid; (*h*) motor switch; (*i*) repair door; (*j*) adjustable gear shifter; (*k*) illuminator switch; (*l*) kymogram.

(11) Some means for securing the patient in an immobile position should be provided on all kymographs, as all motion extraneous to that of the structure being studied must be eliminated.

Our original kymograph was made and designed by the Dick X-ray Company and contained many of the above-listed features. During the development of the work it became apparent that certain improvements and refinements were desirable. Chief among these is the provision for interchangeable grids with slits spaced 6, 12, and 18 mm. apart (Fig. 3). This necessitated a revamping of the x-ray contact points so that the exposure would

An accurate time record graduated in either seconds or one-fifth of a second was obtained by incorporating a Jaquet graphic chronometer clock.[13]

A small compression binder was attached to the instrument for maintaining the patient in an immobile position during the exposure.

The installation of a mechanism permitting either the film or grid to move while the other remains stationary is not feasible in the instrument which we have used. A kymograph embodying this feature and the above listed items is now being made.

[13] Obtained from the Arthur H. Thomas Company, of Philadelphia.

Most of the mechanical units will be grouped below the lowest position of the film and at the sides. This will allow the

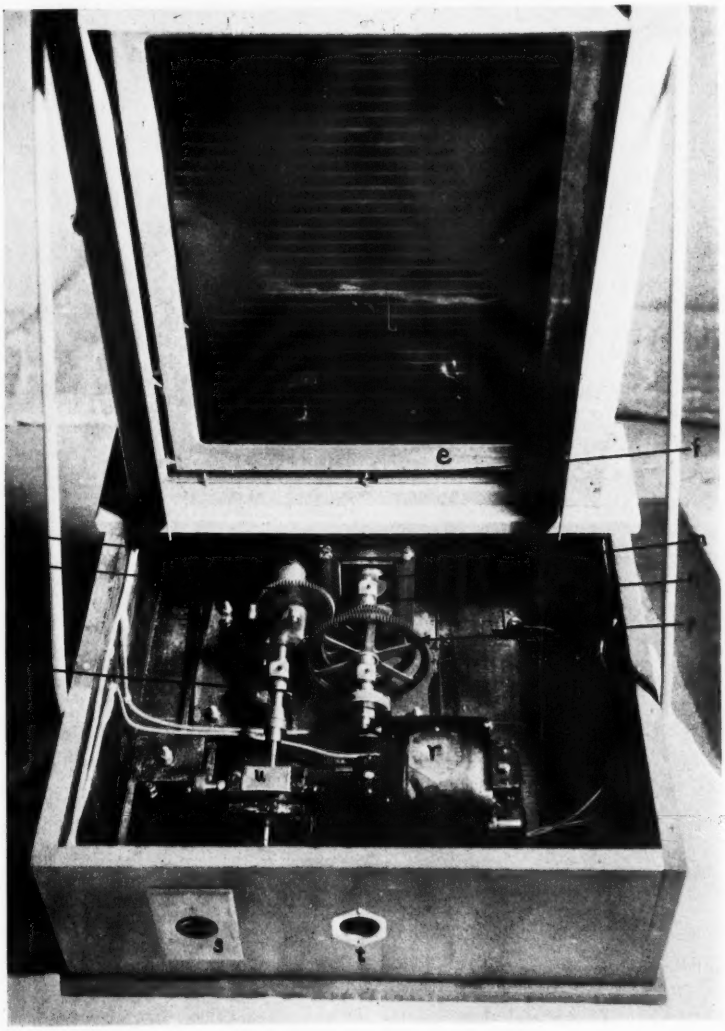

Fig. 7. View of mechanism of kymoscope. (*m*) Concentric cam; (*n*) actuating mechanism for film frame; (*o*) main drive gear; (*p*) speed ratio gears; (*q*) rotating switch for illuminator; (*u*) transmission gear box; (*r*) synchronous motor; (*s*) outlet plug for illuminator; (*t*) main supply plug.

optional use of a fluoroscopic screen placed at the back of the outer casing. The screen makes it possible to position a patient when using a smaller film, 11×14 or 10×12. It also aids in placing the slits at right-angles to any structure, the movements of which are to be accurately registered, particularly in the field of research.

In general it appears to us that two types of kymographs should be developed. One, an instrument that is simple, light in weight, inexpensive, allows only the film to move, and may be hung on a regulation upright

cassette holder. Such a kymograph would be made for the smaller laboratory in instances in which the work is limited to clinical heart studies.

The second type of kymograph would embody all the above-listed accessories and refinements which permit studies of all types of physiologic movement. This instrument would be designed for routine studies as well as investigative and experimental work and is recommended for hospitals and institutions.

THE CONSTRUCTION OF THE ROENTGENKYMOSCOPE

The roentgen kymoscope is an instrument which makes it possible to project the movements that are recorded on the kymogram in such a manner as to make a continuous picture of these events. The image that is produced resembles that which is seen on the fluoroscopic screen. The projected image may even be termed a "permanent fluoroscopic observation" on a single x-ray film. The development of the kymoscope was another achievement of Pliekart Stumpf's,[9] the principles of which he reported in 1931. Hirsch demonstrated a small kymoscope at the meeting of the American Medical Association in 1935. We have, however, been unable to find a detailed account of the mechanical construction of this piece of apparatus, and the model which we will describe was made in conjunction with the Dick X-ray Company, of St. Louis.

In the roentgen kymoscope (Fig. 5) the film (kymogram) is placed in a frame which moves downward 11 mm. at a smooth, uniform rate of speed—the same distance that the film travelled during the x-ray exposure. After descending 11 mm. the film is quickly returned to the starting position by the action of contracting springs. The slow downward movement is produced by a specially designed concentric cam.

In front of the kymogram is placed a grid similar in design to that of the lead grid used in the kymograph (Fig. 6). The grid in the kymoscope is made from an exposed photographic glass plate on which are cut narrow slits. These are approximately 0.5 mm. in width and are spaced 12 mm. apart. The grid is fastened in a hinged door to allow easy access to the frame in which the kymogram is placed. A regulation x-ray viewing box is placed behind the kymoscope to produce the necessary illumination.

In the electrical circuit to the illuminator there is placed a rotary switch which operates on the same shaft that revolves the cam (Fig. 7). This makes it possible to synchronize the moving of the film and the breaking of the circuit to the illuminator. Thus the illuminator is "on" during the slow downward movement of the film and "off" during the return movement, thereby preventing a projection of images during the upward thrust of the film. An image so produced would picture the events in exactly the reverse of the order in which they actually occurred.

The rate of speed at which the film moves downward is regulated by a small transmission similar to that used in automobiles (Fig. 7). The gears of the transmission vary in size so that not only the original speed of the downward movement of the film is reproduced, but the speed can be varied from 1 to 2, 1 to 3, 1 to 4, or 1 to 5. In using the gear ratio of 1 to 5 the kymogram descends one-fifth as rapidly as the film did during its exposure. This gives the effect of slow motion and makes it possible to reproduce these movements slowly and continuously to permit an accurate analysis.

It should be stressed that a kymoscope is not necessary for the interpretation of the movements shown on the kymogram. In fact, the kymogram can be far more accurately interpreted by measuring the amplitude of the waves and their contour. The kymoscope is of value as a means of explaining the principles of kymography and the operation of the kymograph. It is an aid in teaching groups of students the different types of fluoroscopic images in various types of heart disease. It possesses the advantage of displaying a "fluoroscopic picture" to a group without the hazards of

roentgenoscopic demonstration in the darkened room. One additional use of the kymoscope is that it permits the making of moving pictures of the organs; we have made several such movie films using the 16 mm. ciné-kodak which serves excellently for demonstrating the method for lectures and medical meetings. The mechanical details are fairly well shown in the accompanying photographs, and in accordance with the old Chinese proverb that "one picture is worth a thousand words," we shall not describe the mechanism in further detail.

CASE REPORT

BILATERAL OSGOOD-SCHLATTER'S DISEASE

By JOSEPH F. ELWARD, M.D., *Washington, D. C.*

The pathologic entity here considered is called variously Osgood-Schlatter's disease, Schlatter's sprain, Schlatter's disease, enlargement of the tibial tuberosity, adolescent tibial tuberosity, separation of the tibial tubercle in adolescents, epiphysitis of the tibial tubercle, fracture of tibial tubercle, periostitis of the tibia, epiphysitis tibiæ, and occasionally, though incorrectly, avulsion of the tibial tubercle.

Apparently the first well authenticated case recorded in the literature was reported by Paul Vogt (1) in Germany in 1869. This early contribution to our knowledge of the condition was made many years prior to the discovery and application of roentgen rays, these enabling Osgood (2) and later Schlatter (3) to recognize and to present elaborately detailed descriptions of the disease in English and German in 1903 and 1908, respectively, hence the hyphenated eponym by which the malady is generally known.

Since the pathology of the affection is dependent mainly upon a study of the anatomy and development of the upper end of the tibia, a brief exposition of the essential features which are involved appears permissible. The upper portion of the tibia usually develops from one center of ossification, forming the upper articular surface and a tongue- or beak-like projection anteriorly, and extends downward over the diaphysis, although the tibial beak may have a separate center of ossification of its own, the complete process of ossification varying in duration from puberty to 20 years. The tendon of the quadriceps femoris muscle (patellar tendon), attached to this tibial tubercle, sends out lateral aponeurotic expansions attached to the anterior portion of the tibia and to the internal and external sides of the tibial beak, this fact accounting for the occasional fractures of the latter which apparently entail no loss of extensory power of the quadriceps femoris muscle. Thus, while the direct attachment of the quadriceps ligament is separated, its lateral expansion is left intact.

Ordinarily the disease attacks the tubercle of the tibia in growing boys and girls, although according to the consensus of opinion, it occurs much more frequently in boys, at or about the age of puberty, namely at from 13 to 16 years, and prior to ossification of the epiphyses. While the affection is usually confined to adolescents, Joseph Vogt (4), who conducted an exhaustive examination of the literature on

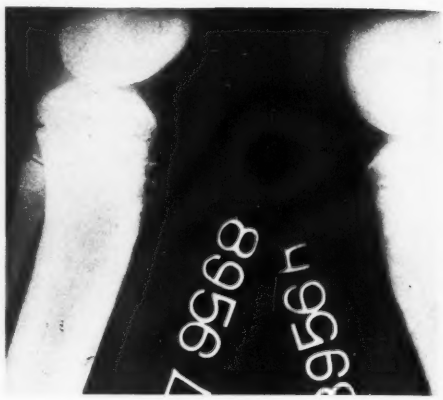

Fig. 1.

the subject in 1919, collected eleven cases of the unilateral type in adult males ranging in age from 20 to 58 years, in addition to 62 cases in males and five cases in females aged from 11 to 19 years, three of which were bilateral (all in males). The sex of a fourth patient who likewise presented a case of the bilateral form, was not specified. In 1928, Legal (5) published the results of direct personal observation and study of 17 cases, 13 in males and four in females, six of them bilateral (again all in males), the patients varying in age between 13 and 15 years. Taft (6), in 1929, reported eight cases in subjects aged between 14 and 18 years, seven males and one female, his series including three cases of bilateral affection, two in males and one in a female. In 1932, Lance (7) demonstrated a bilateral case in a boy aged 14 years. Puente (8), in 1933, contributed the latest recorded case of bilateral involvement in a boy aged 11 years. Thus, out of a total of 103 cases comprised in the literature up to and including 1933, only 13 were of the bilateral type, the general proportion of approximately one in nine attesting the extreme rarity of this form of the disease.

The problem of the precise etiology of the affection is as yet unsolved. Various hypotheses have been adduced to explain its origin, namely: (*a*) a developmental fault at the stage of active bone growth; (*b*) a dyscrasia of the endocrine glands; (*c*) an infective agent of attenuated virulence, and (*d*) trauma (9). Osgood and Schlatter, in turn, favored the latter theory, Schlatter asserting specifically that fracture of the beak-shaped process of the upper tibial epiphysis was invariably involved. The validity of the traumatic hypo-

thesis has subsequently been confirmed by practically all students of the disease, since virtually every case thus far reported is characterized by a history of antecedent injury. Accordingly, the theory remains the most tenable of all those thus far advanced. However, occasional cases which would appear to bear out the possibility of an infective etiology are said to have been noted following low grade infection. Rickets has been referred to as a possible cause by a few observers who encountered the affection in children exhibiting definite rachitic changes. Tuberculosis of the epiphysis has likewise been assigned as a potential etiologic factor.

Pain over the patellar tendon and pretibial tubercle, sometimes comparatively slight and frequently intermittent, is perhaps the most common symptom. Limitation of motion, chiefly extension, is a variable sign. Periarticular swelling, usually due to direct trauma to the part, is ordinarily present. Local pretibial tenderness is a reliable indication of the affection.

The disease should be carefully differentiated clinically from (*a*) sarcoma, which occurs frequently at the upper end of the tibia, but rarely involves the tubercle itself; (*b*) tuberculous arthritis, since the dense synovitis resulting from severe injuries or infection is sometimes misinterpreted as early tubercular involvement of the knee; (*c*) syphilis, the indistinct hazy appearance of the outline of the tubercle, with the commonly associated synovitis, being occasionally mistaken for syphilis, and (*d*) osteomyelitis, in which presence of bone production or destruction, occurring simultaneously or independently in conjunction with a periostitis serves to differentiate this condition from Osgood-Schlatter's disease.

The affection may be differentiated without difficulty roentgenologically from (1) fracture into the joint at the upper end of the tibia, (2) traumatic avulsion of the tibial tuberosity, and (3) bursitis (the bursa behind the ligamentum patellæ sometimes becoming secondarily involved following Osgood-Schlatter's disease). Differential diagnosis from osteomyelitis of the upper end of the tibia, syphilis, and sarcoma may also be effected with comparative certainty by means of roentgen-ray examination.

Radiologic findings vary according to the extent of damage to the bony parts, which depends in turn upon the degree of applied force. Thus, following mild muscular efforts, relatively slight injury with only partial incomplete separation of the apophysis results, while in direct trauma or severe muscular strains there is more extensive separation, the amount depending on the degree of development of the part, the lower pole of the tubercle being occasionally pulled loose and displaced upward and forward in front of its upper half and united in this position. In infective cases, the tubercle exhibits a somewhat different aspect, a fuzzy, slightly irregular appearance, seemingly limited, being noted in the early stages of the disease, following which reactive processes are observed, the substance as well as the margins of the bone becoming denser and small bony proliferations being remarked, these extending outward from the periphery of the tubercle, as seen ordinarily in a non-suppurative inflammatory process involving bone. In general, a roentgenogram which reveals alteration in texture, irregular contour, or fracture of the epiphyseal lip of the tibial tubercle may be accepted as conclusive evidence of the presence of the disease. Roentgen-ray examination of both knees is advised by the majority of writers on the subject, radiographic studies of the opposite knee sometimes disclosing practically the same osseous condition as the affected knee (10).

The prognosis is generally excellent, the tibial tuberosity usually uniting ultimately with the diaphysis. Open operation for the removal of the fragmented tibial tubercle is believed to be warranted only in case of interference with this process of union in consequence of further trauma to the injured part.

Treatment of the acute symptoms consists of rest in bed, with hot applications continued until pain and swelling subside, following which an elastic support should in some instances be worn on the affected knee for a few weeks. When thus treated, complete healing of the pathologic lesion usually occurs in a few years, with practically no intercurrent disability, since separation of the tibial tuberosity (bilateral) is present prior to observation of trauma or symptoms (11).

An additional case of bilateral Osgood-Schlatter's disease from the author's own practice is reported below.

HISTORY OF CASE

A white boy, aged 12 years, complained of a dull pain in the knees on ascending and descending steps. The family history was unimportant. His past history included the usual diseases of childhood, measles, whooping cough, and chicken pox. A tonsillectomy had been performed three years previously. Five months prior to the onset of symptoms the patient had fallen several feet from a tree, but was unable to recall whether he struck his knees at the time. A dull, aching pain in both knees, becoming more severe while going up and down stairs, was first remarked two weeks before examination. The pain persisted more or less continuously, with simultaneous occur-

rence of swelling and tenderness just below the knees, and was more severe at night than in the morning. Rest afforded some temporary relief. Physical examination revealed moderate swelling, local heat, and tenderness in the bursæ over the tibial tubercles. Pain accompanied any movement involving the contraction of the quadriceps muscle.

Radiographic Examination.—The bones about the knee joint all showed normal bone trabeculations and normal density, with normal epiphyseal development for the patient's age. The joint spaces showed no abnormality in width. There was no evidence of cartilaginous destruction. Noticeable swelling was remarked in the soft tissues in front of the tibial tubercles, due undoubtedly to a bursitis, an almost invariable accompaniment of this condition. The tubercles themselves presented a slightly different appearance on the two sides, being broken up on the right into two fragments, a larger lower, and an upper smaller, while on the left there were three fragments, apparently hugging closely to the diaphyseal portion of the tibia. There was no bony bridging between the epiphyseal fragments. Each epiphyseal fragment was star-shaped, with the appearance of large snowflakes. There was marked rarefaction in the tubercles, an indirect indication of non-interference with the blood supply and, in the event of possible vascular changes, of the existence of an hyperemia rather than an anemia to the part. In a comparison of this picture with that of an ordinary fracture of the tibial tubercle, there is seen in the latter case an elevation of the tubercle with two transverse fracture lines through it, but no decreased density or other architectural alteration in the tubercles.

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EDITORIAL

LEON J. MENVILLE, M.D., *Editor* HOWARD P. DOUB, M.D., *Associate Editor*

RADIOLOGY AS A VALUABLE AID TO NEUROPSYCHIATRY

I should not have to think long if I were asked to name the specialty which had rendered the most valuable service to all of the different branches of medicine. I should unhesitatingly name radiology. No other branch of medicine has such a widespread application and none other has made such wonderful strides within the last few years as it has. Its daily use by all branches of medicine is well known to us all, and we neuropsychiatrists in particular appreciate its helpfulness in the practice of our specialty. At times diagnoses are made with the roentgen ray which are almost uncanny, and we often ask the question: By what method does the radiologist find out the hidden secrets within the human body? While the neuropsychiatrists appreciate the importance of laboratory and roentgenologic examination, these alone would not be sufficient in all cases to correctly diagnose and treat all diseases of the nervous system, but the correlation of the laboratory findings along with an efficient and thorough neurologic examination by a trained physician becomes of great value. Yet ever so often we see very sick patients, who have for a long time received inadequate and incorrect treatment by inexperienced physicians who, because of lack of sufficient medical knowledge, failed to give these patients the advantage of modern methods of examination. As a result many of these patients, who would in many instances have responded to treatment in the early stages of their disease had the case been correctly diagnosed, come to the neuropsychiatrist in a condition of chronic illness. For instance, often the neurologist is called upon to treat a patient who manifests extreme nervous symptoms and also complains of some gastro-intestinal disturbance, which condition has been diagnosed by some well-intentioned but misguided physician as nervous indigestion. A roentgen-ray examination in such a case will often reveal a peptic ulcer or even carcinoma of the stomach. This is mentioned because I wish to emphasize the importance of a thorough survey of the gastro-intestinal tract of all nervous patients complaining of gastro-intestinal symptoms before making a diagnosis of neurosis.

The roentgen ray is used to-day for so many neurologic conditions that it would be impossible for anyone to discuss its merits in so short a dissertation. However, some of its more recent brilliant achievements in this regard will be briefly discussed.

Hidden foci of infection which play an important part in nervous diseases are clearly revealed by means of the roentgen ray, whether the infection is in the sinuses, teeth, gall bladder, or gastro-intestinal tract.

X-ray examination of the skull will often give most valuable information to the neuropsychiatrist. Plain x-ray films will not only show whether or not a fracture is present, but whether it is pressing upon vital structures within the cranium. Prominent grooves for the veins of the diploe and other blood vessels are readily visualized in a plain x-ray film and these findings may at times be of some importance in a study of the skull. Evidence of intracranial pressure with its accompanying bone changes is not difficult to detect with a simple x-ray film. Areas of calcification which may or may not signify the presence of intracranial tumor are clearly visualized. Also, calcification of the pineal body is often observed, and when x-ray examinations are made at intervals, showing a shifting in the position of the calcified shadow, this will often be of help regarding pressure and displacement of certain structures within the skull. Perhaps the two most important uses of roentgenologic examination in diagnosing brain tumors are ventriculography and encephalography. These methods of examination are so well known that I shall only mention certain phases of them. Ventriculography is regarded as being the procedure of choice in diagnosing suspected tumors of the posterior cranial fossa, while encephalography, considered a safer procedure than ventriculography, is contra-indicated. It has been found most useful in certain types of intra-cranial tumors, brain injuries, brain atrophy, and brain absorption. Some have found it to have

a definite therapeutic benefit in chronic convulsive reactions and in post-concussion syndromes of head injuries. Recently, thorium dioxide has been used as an opaque medium in ventriculography. We are not sure that the use of this substance is free from danger. Thorium being a radio-active element, when injected intravenously in the form of thorium dioxide is absorbed in large amount by the reticulo-endothelial system, where it may be stored for a number of years.

The diagnosis of pituitary tumors by means of the roentgen ray is of common occurrence and its efficiency in this regard is so well known that a mere mention of its importance should be sufficient. Recently there have appeared in the literature reports of several cases of hydatid disease of the brain in which the roentgen ray was used in the diagnosis. In some of these cases the roentgen-ray examination was negative, while in others it proved of great value. In one case the ventriculogram showed a hydatid cyst containing air, with some distortion and displacement of the ventricular system. The report of six cases of facial and meningeal angiomatosis with calcification of brain cortex in which the roentgen ray played an important part in the diagnosis is of especial interest. Another important use for encephalography has been found in the diagnosis of agenesis of the corpus callosum. It has also been used to visualize suprasellar tumors, becoming in this regard of great value. The use of the roentgen ray in the diagnosis and treatment of syringomyelia is now considered of great importance. The interesting work of Camp on the diagnoses of spinal cord tumors is considered classical and is but another evidence of the momentous importance of roentgenology to the neuropsychiatrist. Another interesting advance made in the field of roentgen-ray diagnosis is the visualization of portions of nerves when an opaque medium such as thorium dioxide is injected into the nerve, so that neurography is now considered a real advance in a new field of diagnosis. The visualization of part of the vascular system is now a practical procedure, so that arteriography has been and now is playing an important part in helping us to solve some of our ambiguous neurologic problems, the vessels being injected with thorium dioxide which is opaque to the roentgen ray and casts a clear and well-defined shadow of the blood vessels. It would be possible to continue to expatiate upon the value of the roentgen ray in the diagnosis of neurologic problems, but it would require many pages of written matter to do this. However, those who are interested will find the current radiologic literature replete with interesting and instructive articles on this subject.

Let us not overlook the importance of irradiation therapy in certain brain tumors and also some of the diseases which involve the nervous system. Recently it has been shown that irradiation of the pituitary gland has relieved many and cured a certain number of patients suffering with menopausal symptoms which were intractable to all other forms of treatment.

While we appreciate the usefulness of radiology to the neuropsychiatrists, we also appreciate that its usefulness is commensurate to the experience and skill of those who are to make the interpretation for us. Because a physician owns and uses an x-ray apparatus does not signify that he is the proper person to be entrusted with cases of nervous disease for roentgen diagnosis or roentgen-ray and radium treatment.

ROY CARL YOUNG, M.D.

From the Department of Neurology and Psychiatry, The New Fenwick Sanitorium, Covington, La.

REPORT OF COMMITTEE ON STANDARDIZATION OF X-RAY MEASUREMENTS

I. PROGRAM

At the 1934 meeting of this Committee, a general program of study for the next three years was agreed upon. Definite questions have been left open by the International Committee on Radiological Units. While these will be studied by their executive committee, it is important that each individual country be adequately prepared to present its needs for consideration.

Accordingly, the points for our future consideration will be:

1. The measurement of low voltage x-rays, high voltage x-rays, and gamma rays in comparable terms;

2. The re-wording of the definition of the roentgen to introduce greater simplicity and any new requirements necessitated by the measurement of the gamma rays (*cf.* our report, RADIOLOGY, March, 1934, **22,** 289);

3. The clinical measurement of high voltage x-rays with particular reference to existing types of dosage meter;

4. The establishment of a standard treatment technic recording chart.

Since the first three points are essentially of a physical nature, it was agreed to leave their study entirely in the hands of the physicists on the committee until the time when completed devices are ready for clinical use by the physician.

II. TREATMENT CHART

For several years the Committee has discussed the preparation of a standard treatment specification chart. Its recommendations on this subject have been published as parts for the general reports but not in a form suitable for general clinical use. Such a chart should, in addition to the necessary treatment factors, be accompanied by general directions for making the necessary measurements.

When the report is adopted by the Committee, the Editor of RADIOLOGY should insist upon its uniform use in publications. Preparation of the chart draft is now in the hands of a subcommittee and will probably be agreed upon within a few months.

It was suggested that a similar treatment specification chart be prepared for the use of radium and radon but it was agreed that this should be delayed at least until the x-ray chart has been completed and tried out.

III. MEASUREMENT OF DOSAGE

The mode of measuring and expressing a dose was again discussed and the Committee's earlier agreements were upheld and emphasized. *The descriptions of dosage are to include in all cases a statement of the quantity of the radiation in roentgens measured in free air with a thimble chamber.*

Measurements including scattered radiation may be given if desired, but only if accompanied by the proper free air measurement. The two shall be carefully distinguished. Attention is called to a motion presented before the American Roentgen Ray Society along similar lines, about two years ago.

It is recommended that the use of thimble chambers attached to the inner surface of compression cones be discouraged since their indications may be ambiguous when used for dosage measurement. Attention is directed to the use of indicating chambers built into the cone of shockproof tube holders. If such chambers are placed too near the tube, serious error may result from the large temperature changes usually undergone.

IV. FILTER AND ABSORPTION DATA

The quality of x-radiation shall be expressed in terms of the complete absorption curve in a suitable metal. The absorption curve may be described in terms of (1) the equivalent voltage (constant potential necessary to yield the curve), or (2) the half value layer. The forefilter must always be given.

Effective wave length and average wave length designations shall not be used.

It should be emphasized that any quality determinations made through absorption measurements should be directly related to a full absorption curve and, hence, constitute a mode of describing the curve or some property of the curve. Depending upon the method employed, the full absorption curve is more or less nearly described. The "equivalent voltage" method gives all points on the curve, and the "half value layer" method gives two points, which is frequently sufficient. The "second half value layer" method gives three points, but necessitates obtaining enough data to set up the full absorption curve in any case.

The following filter combinations are recommended:

Kv. (approx.)	*Forefilter*	*Absorbing Filter (for quality)*
30–120	Aluminum	Aluminum
100–250	Copper	Copper
200–400	Tin or copper	Copper[1]
400–up	Lead	Lead

V. SECONDARY STANDARDIZATION LABORATORIES

In response to repeated requests, the National Bureau of Standards has set up the following general requirements for secondary x-ray standardization laboratories:

"General Requirements for X-ray Standardizing Laboratories

"1. Equipment must be in charge of a full-time physicist, whose special field is that of x-rays and whose basic training has been in physics.

"2. The standardizing laboratory must be equipped with the necessary working standards

[1] Even though tin is slightly more discriminating, the difference is not enough to be of great importance, and it is desirable to keep the list of absorption materials small.

for effecting a complete calibration of the current measuring system.

"3. Standardizing equipment must be maintained in working order and position and not be disassembled except for purposes of normal maintenance.

"4. Basic parts of the standardization equipment must be compared against that of the National Bureau of Standards (or the National Research Council of Canada, if in Canada).

"5. Standardization equipment must be inspected *in situ* by a physicist selected by the N. B. S. or the N. R. C. C.

"6. Standardization equipment must be in accord with 'X-ray Standards and Units Standardizing Procedure of the National Laboratories' (Am. Jour. Roentgenol. and Rad. Ther., 1934, **31**, 815).

"7. Laboratory must file with the N. B. S. drawings showing all essential details of ionization chamber, tube container, and diaphragm system. Any subsequent changes must be filed with the originals.

"8. Calibration reports must conform with those of the N. B. S. and bear suitable serial numbers; copies of all reports to be sent to a central file at the N. B. S. at least every three months."

These requirements have been ratified by the several laboratories in this country which are already doing such work.

VI. REGISTRATION OF X-RAY PHYSICISTS

The Committee has discussed in detail the question of the calibration of x-ray machines in hospitals. In this connection our attention has been directed to numerous abuses along such lines by persons unqualified to make such calibrations. It was decided, therefore, to set up a Registry of X-ray Physicists, listing physicists who, in the Committee's opinion, are suitably qualified for consultation and to make calibrations of x-ray machines. It is felt that this will offer protection both to the physician and physicist. It was agreed that a Registered X-ray Physicist should meet the following requirements:

1. Be a recognized physicist working in the radiological field;

2. Show a reasonable working knowledge of physics in the radiological field;

3. Be familiar with the classical x-ray theory;

4. Appear before a board selected by the Standardization Committee for examination if deemed advisable by that Board.

5. Use only such dosage instruments as are approved by the Committee and tested by a recognized testing laboratory. (For example, National Bureau of Standards, Cleveland Clinic, Memorial Hospital, National Research Council of Canada, or Temple University Hospital.)

6. Not be directly employed by any x-ray equipment manufacturer, agent, or distributor.

In this connection, the following motion was offered before the Radiological Society of North America in executive session at the 1934 Memphis meeting:

"I move that the Standardization Committee of this Society be authorized to set up a list of approved individuals who may give certificates of calibration of any type of x-ray equipment. This applies only to non-medically trained men."

This resolution was subsequently adopted by ballot, after the meeting.

In accordance with requirement (4) the Committee has appointed, for an indefinite period, the following examining Board:

R. R. Newell,	G. Failla,
Otto Glasser,	L. S. Taylor

Any member of the Board may examine an applicant, submitting a report and recommendations to the other members of the Board for final action. All papers relating to an applicant will be filed at the National Bureau of Standards.

In connection with the resolutions given above, the Standardization Committee of the Radiological Society of North America agrees that the following physicists meet the requirements of the Examining Board:

C. B. Braestrup,
Otto Glasser (1, 2, 3),
Robert Landauer,
L. D. Marinelli,
A. Mutscheller,
G. Failla (1, 2, 3),
E. Quimby (1, 2, 3),
P. A. MacDonald,
A. Nurnberger,
C. T. Ulrey (1),
J. L. Weatherwax (1, 2),
C. C. Lauritsen (1),
L. S. Taylor (1, 2, 3),
G. Singer (1),
G. C. Laurence (1, 2),
W. Stenstrom (1, 2, 3),

G. Henny (1),
J. K. Robertson,
K. S. Cole (1),
F. M. Exner (1).

It was also suggested that all such physicists must be members of some recognized radiological or physical society. This is for the partial purpose of evidencing their continued interest in radiological work. Numbers following the above names refer to society membership, *i.e.*: (1) Physical Society; (2) Radiological Society of North America; (3) American Roentgen Ray Society.

It should be emphasized that even more important than actual society membership is the frequent attendance of meetings.

It was further suggested that any physician offering consultation on physical measurements should submit to the same authority that is certifying a physicist offering the same consultation.

VII. MISCELLANEOUS

Last June, an informal meeting of radiation physicists was held at Minneapolis for the purpose of discussing super-voltage x-ray problems. It was proposed at that time that this Committee be the official outlet for the results obtained as a consequence of that meeting. A report will be published.

In response to numerous suggestions that this Committee study certain standardization problems in the field of diagnostics, it will prepare a questionnaire seeking the specific problems upon which standardization is desirable and feasible.

A sub-committee is studying the question of uniform definitions, abbreviations, and symbols of physical terms used in the radiological field. In the meantime, it endorses and recommends the use (1) of the definitions prepared by the American Standards Association (Project C-42), "Definitions of Electrical Terms" (2), "Abbreviations for Scientific and Engineering Terms," O.S.A. Standard ZIOi—1932, and (3) "Metric Abbreviations," Abridged Style Manual, Government Printing Office, 1933, pp. 60, 61, under Rules 79 and 79*a*.

For the Committee:

LAURISTON S. TAYLOR, *Chairman*,
U. V. PORTMANN, M.D., *Sub-chairman*

February, 1936

ANNOUNCEMENT

INTERNATIONAL CANCER CONGRESS

From September 20 to 26, 1936, there will be held in Brussels, the second International Cancer Congress under the auspices of the International Union Against Cancer.

The program of the Congress has been divided into four main groups: (1) Experimental investigation of cancer, which comprises the study of carcinogenic substances, transmissible agents and viruses, growth substances, and the factors of predisposition and resistance such as heredity, metabolism, and immunity; (2) The diagnosis of cancer by histological, radiological, and serological methods; (3) The therapy of cancer, medical, surgical, and radiological; (4) Education of the lay public, such as access to diagnosis and treatment, provisions for incurable cases, and statistics.

The list of participants is not yet complete but among those who will make official reports are: Professors M. Borst (Germany); J. W. Cook (England); W. Cramer (England); H. F. Deelman (Holland); L. I. Dublin (United States); A. P. Dustin (Belgium); J. Ewing (United States); W. E. Gye (England); H. Holthusen (Germany); E. L. Kennaway (England); J. Maisin (Belgium); M. Nagayo (Japan); F. Pentimalli (Italy); C. Regaud (France); P. del Rio Hortega (Spain); G. Roussy (France); C. Rowntree (England); H. Schinz (Switzerland), and Francis Carter Wood (United States).

The International Union Against Cancer was organized in March, 1934, at the request of the delegates to the International Cancer Congress in Madrid, October, 1933. Eighty delegates, sixty of whom came from Europe and the remainder from other parts of the world, met in Paris under the chairmanship of the French Minister of Public Health, and adopted the necessary statutes for the proper functioning of such an international organization. It was agreed by vote of the delegates that the central office should be in Paris, and the executive and special committees were constituted. One of the important tasks of the Union is the holding of international cancer congresses, and it was decided by the executive committee that the 1936 Congress should take place in Brussels.

The Congress is open to members of such scientific or educational organizations as have joined the International Union Against Cancer.

The dues for participants in the Congress are 100 Belgas, or approximately $17. Further particulars may be obtained from Mr. W. Schraenen, General Secretary to the Congress, 13 rue de la Presse, Brussels, Belgium.

COMMUNICATIONS

AMERICAN RADIUM SOCIETY

ANNUAL MEETING, MAY 11, 12, 1936

The 1936 annual sessions and program of the American Radium Society was held at Kansas City, Missouri, at the Hotel Kansas Citian, on Monday and Tuesday, May 11, 12, 1936. Dr. George W. Grier, of Pittsburgh, Pa., was President and Dr. Edward H. Skinner, of Kansas City, was Secretary. Dr. Zoe Allison Johnston, of Pittsburgh, Pa., was installed as President for the coming year.

The feature of the meeting was the Janeway Lecture, delivered at the Annual Banquet on Monday evening at the University Club. The Janeway Lecture serves to honor a pioneer radium therapist, the late Henry H. Janeway, M.D., of New York City. The lecturer this year was Dr. Curtis Burnam, of Baltimore. Dr. Douglas Quick was Chairman of the Janeway Lecture Committee and presented the Janeway medal to Dr. Burnam. The previous annual lecturers were Dr. James Ewing and Dr. Francis Carter Wood, of New York City, and Dr. George E. Pfahler, of Philadelphia.

MINNESOTA RADIOLOGICAL SOCIETY

The Spring Meeting of the Minnesota Radiological Society was held at the St. Paul Athletic Club, St. Paul, Minn., Saturday, March 28, 1936. The following program was presented:

1. Demonstration of Device for Serial Examination of the Duodenal Bulb. H. Milton Berg, M.D., Bismarck, N. D.
2. Roentgen Findings in Monilia Infection of the Lungs. Kano Ikeda, M.D., St. Paul.
3. Radium Treatment of Post-operative Parotitis. Robert Fricke, M.D., Rochester.
4. Roentgenologic Findings in Chronic Gastritis. Russell W. Morse, M.D., Minneapolis.
5. Roentgenologic Changes in Non-tropical Sprue. John D. Camp, M.D., Rochester.
6. Congenital Solitary Kidney with Traumatic Rupture Clinically Diagnosed. Lester G. Ericksen, M.D., Dubuque, Iowa.
7. Roentgen Treatment of Carcinoma of the Ovaries. Lewis Jacobs, M.D., Minneapolis.
8. Roentgen Diagnostic Quiz. Conducted by Leo G. Rigler, M.D., Minneapolis.

An informal dinner was held, following which there was an address by the guest of the Society, Dr. Ernst A. Pohle, of Madison, Wis., on the "Radiological Treatment of Leukemia and Allied Disorders."

CONNECTICUT STATE MEDICAL SOCIETY

RADIOLOGICAL SECTION

A meeting of the Radiological Section of the Connecticut State Medical Society was held at the Hartford Hospital, Thursday evening, April 9, at 8:00 P.M. Dr. Douglas Roberts and Dr. Ralph Ogden presented an illustrated paper on "Roentgen Diagnosis of Regional Ileitis." Other interesting cases were shown and discussed by members of the Section.

Dr. Charles W. Perkins, of Norwalk, is Chairman of the Section and Dr. Max Climan, of Hartford, is Secretary-Treasurer.

NOTICES OF CORRECTION

In the paper by Dr. L. H. Garland, Dr. A. V. Pettit, Dr. R. D. Dunn, and Dr. P. Shumaker in the April, 1936, issue of RADIOLOGY, pages 443–453, the following changes should have been made: Figure 11 should have been omitted; the caption appearing under Figure 11 should be read under Figure 12 and the caption under Figure 12 should be read under Figure 13.

The Editor regrets the necessity for these changes.

Dr. I. Seth Hirsch wishes to amend the Summary of his paper entitled "Pulmonary Changes in Polycythemia Vera" in RADIOLOGY, April, 1936, **26,** 469–473, to read as follows:

"The lungs in true polycythemia may show two types of nodular lesions: one, a conglomerate tubercle which differs in no way from the formation not infrequently found in the

absence of polycythemia, and the other a sharply defined nodular lesion which appears to be characterized by multiplicity, homogeneity, and transientness."

IN MEMORIAM

C. A. H. FORTIER, M.D.

Dr. C. A. H. Fortier, widely known roentgenologist, died suddenly March 7, 1936, at his home in Milwaukee, Wisconsin, following a cerebral hemorrhage. His practice was limited to the x-ray and deep therapy specialty, in which he was associated with his son, Dr. C. A. H. Fortier, Jr. His father was a French Canadian physician and surgeon who received his Master's degree in Surgery from McGill University of Canada. Born in 1876 at Chippewa Falls, Wisconsin, he obtained his preliminary education at Florence, Wisconsin; University of Ottawa in Canada, and Lake Forest Academy, Lake Forest, Illinois. Later, he attended the University of Wisconsin from which he received his Bachelor's degree and in 1911 was graduated from Marquette University School of Medicine. Beginning in 1913, he specialized in roentgenology, being one of the pioneers in this field and also one of the first radiologists in the State of Wisconsin. The first Coolidge tube in this State was demonstrated in his office.

He was a member of the Milwaukee County Medical Society, the Milwaukee Academy of Medicine, the Wisconsin State Medical Society, the American Medical Association, the Milwaukee Roentgen Ray Society (of which he was at one time president) and of the Radiological Society of North America, serving as Counselor for the State of Wisconsin.

He was consulting radiologist for the Milwaukee Railroad. Formerly, he lectured on roentgenology at the Marquette University Medical and Dental Schools. At various times, he was on the staffs of the Johnson Emergency, Milwaukee County, Deaconess, Maternity and General, St. Luke's and St. Joseph's Hospitals in Milwaukee; St. Mary's and St. Luke's Hospitals in Racine, and the Memorial Hospital at Burlington as roentgenologist.

He served in the World War at the Naval Base Hospital No. 30 as roentgenologist, and prior to this, early in 1917, he acted as Roentgen Advisor to Advisory Boards Nos. 1 and 4, of Milwaukee. He held the rank of senior lieutenant during his war services.

C. A. H. Fortier, M.D.

He proved a most capable educator when giving up his time to teaching and took up his work in the field of roentgenology with thoroughness and determination, where his skill and ability brought him prominently to the front in the line of his specialty.

Dr. Fortier is survived by his wife, Mrs. Sophie Peek Fortier; a daughter, Suzanne, and a son, Dr. C. A. H. Fortier, Jr.

BOOK REVIEW

L'ACTION DES RAYONS ULTRA-VIOLETS ET DES RAYONS X SUR LES NERFS PERIPHERIQUES (THE ACTION OF ULTRA-VIOLET RAYS AND X-RAYS ON THE PERIPHERAL NERVES). By JACQUES AUDIAT. A volume of 88 pages, with 23 illustrations (diagrams and curves). Published by Masson et Cie, Paris, 1936. Price, 25 francs.

This is a report of experiments undertaken to determine the functional effects on nerves of massive doses of ultra-violet and roentgen rays. These experiments appear to have been carried out with great care and skill, and the manner in which the author attempts to inter-

pret his results shows a high degree of scientific reserve. In connection with effects produced by roentgen rays, the description of technical details of irradiation is ambiguous. How can rays, generated at 110 kv., and filtered through only 0.1 mm. of aluminum, be regarded as very penetrating? Probably this represents a natural difference between the point of view of the experimental physiologist and the medical radiologist. Also, the use of such massive doses as 300,000 roentgens (international unit) makes one wonder how a nerve or any other living structure could fail to be influenced. Another point which is not clear is how 300,000 roentgens could be obtained in ten minutes with the voltage and filtration given. Aside from these considerations, the author's experiments, as well as his results, will appeal to physiologists and radiologists who are interested in physiologic problems.

ABSTRACTS OF CURRENT LITERATURE

CONTENTS BY SUBJECT

THE FOLLOWING ABSTRACTORS HAVE CONTRIBUTED TO THIS ISSUE

S. M. ATKINS, M.D., of Waterbury, Conn.
W. H. GILLENTINE, W.D., of New Orleans
J. E. HABBE, M.D., of Milwaukee, Wisc.
H. A. JARRE, M.D., of Detroit, Mich.
E. T. LEDDY, M.D., of Rochester, Minn.
D. H. PARDOLL, M.D., of Chicago, Ill.
E. A. POHLE, M.D., PH.D., of Madison, Wisc.
E. M. SHEBESTA, M.D., of Detroit, Mich.
CHARLES G. SUTHERLAND, M.B., (Tor), of Rochester, Minn.

CONTENTS OF ABSTRACTS IN THIS ISSUE, LISTED ALPHABETICALLY BY AUTHORS

BONE DISEASES (DIAGNOSIS)

Bone Tumors. Charles F. Geschickter. Am. Jour. Roentgenol. and Rad. Ther., July, 1935, **34**, 1–29.

To interpret bone disease roentgenologically to its fullest extent, there must be added to the pure roentgen findings the anatomic, embryologic, and pathologic features. With this point in view, bone lesion findings are described as well as the treatment. The author divides bone lesions into two groups, "those which are primarily related to the bone tissues and their development . . . and those which secondarily involve bone either from without by extension or by metastasis, or which are found in the bone because of a relation to vessels or lymphatics."

Exostosis or Osteochondroma.—(1) Normal bony protuberance exaggerated into a base or pedicle; (2) neoplastic cartilaginous cap upon that base; (3) definite calcified demarcation; (4) growth directed in line of muscle pull; (5) widening in shaft in affected region. The site of growth is at the point where the tendon attaches directly to the bone, and results from the growth of the primitive cartilage left in the tendon. The treatment should consist of non-interference unless pressure symptoms are present. This type of tumor rarely becomes malignant.

Multiple Exostoses or Osteochondromas.—A familial history will be present. There will be bending and malformation in the accessory bones (of the forearm and foreleg, in the case cited by the author), characteristic squaring off of the bones in the region of the knee joint (cited case). Treatment and prognosis are the same as in the single exostosis.

Chondroma.—This is most frequent in adults in the small bones of the hands and feet and also in the sternum and spine; that is, where there are a maximum number of joints. Chondromas represent aberrant joint surfaces (cartilage) caught in bone which has proliferated. Roentgenographically, they present central areas of rarefaction, expansion of the shell, escape of the tumor directly beyond the shell, a fine trabeculation, and fine calcareous deposits. In the sternum or any large bone this tumor is potentially malignant. In any of the small bones it is benign, regardless of its microscopic appearance, and is to be left alone. If painful, however, it may be curetted, followed by cauterization. Irradiation is not necessary.

Primary Chondrosarcoma.—This extremely malignant type of tumor occurs during puberty and arises from precartilage tissue. Roentgenographically, the growth presents a fairly invisible periosteal tumor which shows, at times, a few fine radiating spicules extending into the soft parts, with no involvement of the medullary or cortical bone. It also arises where tendon attaches to bone.

Secondary Chondrosarcoma.—It arises from benign exostosis and chondroma and shows progressing invasion and destruction. It occurs in adults. Twenty-five per cent of the cases are cured by radical resection but can be controlled only slightly by irradiation.

Sclerosing Osteogenic Sarcoma.—This gives the characteristic "sunburst" with many radiating spicules of bone and obscures the marrow cavity. It is generally on the shaft side of the epiphyseal line. It occurs most frequently in persons between 14 and 25 years of age. It is not radiosensitive and is best treated by amputation which has cured one-third of the cases reported (still living after five years). Myositis ossificans may give rise to this tumor, especially if interfered with by operation.

Osteolytic osteogenic sarcoma arises from the endosteum, usually in patients under 20 years of age, with symptoms of pain, fever, and slight rise in white count. Roentgenologically, there is bone destruction with periosteal lipping resembling a cyst except for the absence of wall and destruction of cortex. Amputation is the best treatment but irradiation has been known to hold such a lesion in check for from two to three years.

Chondroblastic sarcoma shows periosteal reaction, a faint translucent shadow beyond the bone, and slight bone destruction in the cancellous spaces and subcortical region. It arises from the cartilage of the epiphyseal line. The age of persons suffering with it is practically always between 14 and 19 years. Radiation should be tried before amputation as the tumor seems to be radiosensitive.

Benign bone cyst reveals a fusiform elliptical area of bone destruction within the marrow cavity on the shaft side of the epiphyseal line, expands the cortex symmetrically on either side, and leads to pathologic fracture. The age of the patient is usually under 15 years. This lesion is due to resorption of calcified cartilage. It is best treated by simple fixation for fracture, curetted, crushed, or let alone, as it but rarely causes symptoms.

Acute bone cyst occurs in patients under 15 years of age with a duration of less than six months. It presents as a tumor of the shaft side of the epiphyseal line, with fusiform expansion about an area of bone destruction. Microscopically, it consists of cysts lined by giant cells. Deep roentgen therapy is the best treatment.

Multiple osteitis fibrosa is a type of bone cysts affecting many bones. In these cases the blood calcium is elevated above the normal of from 10 to 12 mg. and the phosphorus may drop to as low as 1 mg. The parathyroids are usually at fault and the removal or irradiation of the diseased glands usually results in relief or cure. Even without treatment there may be remissions.

Diffuse Osteitis Fibrosa.—This refers to diffuse involvement of only one bone, with the calcium and phosphorus normal. It is probably due to local nerve or blood supply disturbance.

Latent Bone Cysts and Brodie's Abscess.—The first refers to a cystic area, surrounded by a thick shell of normal bone and is symptomless. It occurs in adults. Brodie's abscess is a cyst surrounded by sclerosis. There is tenderness and swelling with no history of trauma. Microscopically, it shows evidence of infection. It is most commonly found in the tibia of a growing adolescent.

Benign hemangioma of bone has a soapbubble-like, multiloculated, and cystic appearance, and is located subcortically. Microscopically, it is seen to consist of dilated spaces filled with blood. Irradiation may result in ossification; if this fails, excision results in cure.

Benign giant-cell tumors are found in the epiphyseal end of the bone extending to the joint surface in adults beyond the age of 20. They are destructive lesions, coarsely trabeculated, which perforate the bone cell. They are globular in outline and extend asymmetrically to one side. Of the bone tumors of the lower end of the radius, 90 per cent are benign giant-cell tumors. If they are treated by irradiation, a long time intervenes for reossification; irradiation must not be in excess lest atrophy of muscles occur. Surgical treatment, excision, or curettement followed by chemical cauterization is best.

Ewing's sarcoma involves about one-half of the shaft of the bone in patients usually under 20 years of age. Bone formation with expansion of the shaft is the first sign, followed by splitting of the periosteum. Secondary bone destruction and appearance in the soft parts of a gauze-like edge tumor with continued splitting of the periosteum are later manifestations. This lesion is frequently mistaken for osteomyelitis, especially since the patient usually has a temperature of 100° F. and a white blood count of from 12,000 to 15,000. Pathologically, it is a lymphosarcoma of bone. Irradiation should be applied as it readily responds to this form of therapy and thus differentiates itself from Garré's sclerosing osteitis. Irradiation often causes an inoperable tumor to become operable, though alone it does not result in a cure. The best treatment is thorough irradiation followed by resection or amputation when possible. Three patients treated by irradiation lived from three to four years.

Fibrosarcoma of Bone.—Usually this arises in the soft parts and invades the bone by extension; thus the bone is destroyed from without inward and no periosteal reaction is present. If it arises from fascia, amputation, followed by irradiation, may result in cure; if neurogenic in origin, no treatment is of value.

Metastatic Carcinoma of Bone.—From the breast and prostate, the new bone formation may predominate over the destruction. Radiation therapy relieves the pain and prolongs life in this condition. In differentiation from Paget's disease, the latter shows bowing and involvement of the tibia and the striations are intact. Involvement of one bone is often from a tumor of the kidney. Destruction is at the site of the nutrient vessels without regeneration.

Multiple myeloma shows punched-out areas in the bones, and occurs usually after the age of 35. Most of the long bones, flat bones, and particularly the bones of the trunk are affected. Bence-Jones bodies are found in the urine in 65 per cent of the cases. These lesions are best treated by irradiation.

Blood dyscrasias like pseudoleukemia, chloroma, and lymphoma may cause destruction of bone and periosteal reaction. Neuroblastoma arising in the adrenals in children may produce the same picture. Irradiation is the best treatment.

Many illustrations of the above conditions are shown. The original article should be read, as the above abstract gives but a suggestion of the fine points of differential diagnosis.

S. M. ATKINS, M.D.

An Analysis of Living Patients with Primary Malignant Bone Tumors. Willis C. Campbell. Jour. Am. Med. Assn., Nov. 9, 1935, **105,** 1496–1501.

This was an analysis of 100 cases of malignant bone tumor in which apparent cures have been effected, 14 of which were from the author's private records. Eighty-five were accepted five-year cures from the Sarcoma Registry of the American College of Surgeons; 74 were osteogenic sarcoma, 10 Ewing's tumor, and one myeloma. Of 125 patients with primary malignant bone tumors from his private records, there were 30 living and well, but only the 14 cases in which sufficient time had elapsed to permit of determining probable results and in which he was reasonably certain of the diagnosis were considered.

The detailed case reports of the 14 are reviewed.

The author considers that there has been some improvement during the past decade and that a concentrated effort by members of the profession who treat a majority of the bone lesions of this country, could probably do much to improve the present status of primary malignant bone tumors.

CHARLES G. SUTHERLAND, M.B. (Tor.)

THE BRAIN

The Responsibility of the Roentgenologist in the Detection of Intracranial Tumors. Karl Kornblum. Am. Jour. Roentgenol. and Rad. Ther., June, 1935, **33,** 752–763.

This writer emphasizes the importance of two routine views of the skull, one of which is a true lateral and the other the occipital. While it is obvious that in many instances certain additional films will be indicated or suggested from the routine views, the writer emphasizes his belief that in the majority of cases the evidence obtainable on plain films will be elicited on these key films.

In a series of 446 verified intracranial tumors the incidence of the various roentgen abnormalities occurred as follows: (1) deformation of the sella turcica, 64.6 per cent; (2) convolutional atrophy, 8.8 per cent; (3) calcification of the tumor, 6.5 per cent; (4) widening of the sutures, 4.6 per cent; (5) local bone erosion, 2.9 per cent; (6) local hyperostosis, 1.8 per cent; (7) lateral shift of the pineal body, 1.8 per cent; (8) widened diploic channels, 0.2 per cent.

There are several intracranial conditions which may give rise to symptoms simulating brain tumor clinically and which may give roentgenologic evidence of their non-malignant character on the previously men-

tioned key films. One of these conditions is chronic labyrinthitis, in which condition the occipital view will indicate evidence of old mastoid disease. Another condition is cerebro-hemiatrophy, a condition probably due to intracranial trauma or infection early in life with subsequent failure of the normal development of one of the hemispheres. This condition produces asymmetry of the two halves of the calvarium, one side being smaller than the other, with the bones of the vault somewhat thicker on the smaller side, while the petrous pyramid is larger and the mastoid pneumatization greater than on the normal side. There may also be asymmetry of the perinasal sinuses, best detected in the frontals, the sinuses on the side of the hemiatrophy being larger. Occasionally acute or chronic sinus infection may give rise to intracranial symptoms; hence the pathologic changes in the intracranial sinuses should be routinely looked for and reported in all cases being examined for intracranial tumor.

J. E. HABBE, M.D.

Reliability of Brain Tumor Localization by Roentgen Methods. Fred Jenner Hodges and Vincent Clifton Johnson. Am. Jour. Roentgenol. and Rad. Ther., June, 1935, **33,** 744–751.

In this series of 190 proven brain tumors all of which had neurological examinations, 167 cases had routine x-ray studies of the skull, 41 cases were submitted to encephalography, and 70 cases to ventriculography. In this series 58 per cent were encephalic tumors, 23 per cent tumors of the covering cells, 12 per cent hypophysial tumors, 3 per cent dysembryomas, and 2 per cent vascular tumors. As a result of a review of this material it was shown that 51 per cent were correctly localized by clinical information alone, 12 per cent by routine skull radiography in instances in which neurological methods had failed, 4 per cent by encephalography unassisted, and 25 per cent by ventriculography alone. Taking the 167 cases having routine x-ray studies, 30 per cent showed direct localizing evidences and 70 per cent of the series showed indeterminate or erroneous localization evidence.

J. E. HABBE, M.D.

CANCER (THERAPY)

Mortality Study in Carcinoma of the Uterine Cervix Treated by Irradiation. Robert E. Fricke. Am. Jour. Roentgenol. and Rad. Ther., May, 1935, **33,** 670–675.

Of the 1,117 patients who were treated by radium and roentgen rays at the Mayo Clinic from 1924 to 1933, inclusive, for carcinoma of the uterine cervix, 13 died during the primary course of treatment. The primary mortality rate, therefore, was 1.16 per cent.

Comparison of findings at necropsy of patients who died during the first course of treatment and of those who died during subsequent visits disclosed that acute pelvic infection and hemolytic streptococcal septicemia accounted for most of the deaths in the first group. Rather unexpected findings, however, were that there were as many patients with metastasis to the lymph nodes in the first group as in the second, and that there was a greater number with distant metastasis in the first group than in the second. Distant metastasis occurred mainly to the lungs and to the liver. These distant metastatic lesions were unsuspected and by our present clinical methods were undiscoverable.

The deductions which can be made from analysis of this small group of patients who died during treatment by irradiation are threefold: (1) The prognosis in every case accepted for treatment must be very guarded. The relatives must be instructed that distressing complications may occur and that such complications often terminate fatally, even though the patient appears on superficial examination to be in good general health. The possibility of a serious complication must always be kept in mind.

(2) The best method of keeping the mortality rate as low as possible is to make a thorough study of each individual case and, with suspicion of metastatic involvement or of impaired renal function, to limit treatment so as not to place undue stress on the patient. Such patients should be treated for palliation rather than for cure.

(3) The broken-dose method of treatment seems preferable to the massive-dose technic; the effect appears to be gentler and more gradual and, on the appearance of any serious complication, irradiation may be instantly abandoned. By careful nursing and supportive measures, many of these unfortunate patients may be saved.

S. M. ATKINS, M.D.

Technic and Results of Irradiation in Carcinoma of the Breast: A Review of 1,129 Private Cases. George E. Pfahler and Jacob H. Vastine. Am. Jour. Roentgenol. and Rad. Ther., January, 1935, **33,** 41–49.

The authors are convinced that carcinoma can be made to disappear if sufficient radiation can be brought to bear on all of the diseased cells.

An accurate estimate of the extent of the malignant disease is essential to successful treatment by irradiation, as well as the type, age, duration, whether it is primary, recurrent, or advanced. Thus the technic varies with the individual and can not be standardized. In all cases the saturation method is employed in a fashion that will not harm the heart or lungs—tangentially insofar as possible.

In the primary carcinoma or pre-operative treatment, high voltage is directed tangentially through four fields, covering the mammary, supraclavicular, and axillary regions. Low voltage is used over the anterior mediastinum: 700 to 800 r, usually divided into two doses, over each field in cases in which axillary involvement is present, given in about two weeks' time. If the patient is not operated on, the above treatment is followed with the Keynes technic of interstitial radium, and this, in turn, again is followed by x-ray radiation.

In the post-operative cases, the plan is in general the same as in the pre-operative, except that the mammary and anterior mediastinal regions are treated with low voltage and at least as much irradiation as the pre-

operative. If no pre-operative radiation was given, more than the above is used.

In the recurrent, the nodules are destroyed with either desiccation or three skin erythema doses of 125 kv. with filtration of 2 mm. Al. In the indurated type, along the scar surface, application of radium is best. For the coracoid and axillary regions, high voltage is best, although interstitial radium may help.

In the operable cases with axillary glands, more than twice the number of cases may be expected to be well after five years when irradiation is added as compared with surgery alone. The combined treatment of surgery and irradiation is probably best, but irradiation alone accomplishes nearly as good results. These conclusions were drawn from a review of 1,129 cases treated more than three years before.

S. M. ATKINS, M.D.

DOSAGE

Suggestions Regarding the Formulation of Therapeutic Data in Papers: The Introduction of a "Space Dose Index." R. du Mesnil de Rochemont. Strahlentherapie, 1936, **55,** 139.

The author offers a blank to be used as a standard in the publication of the results in radiation therapy. This blank provides very complete information and comprises thirty-two columns.

ERNST A. POHLE, M.D., Ph.D.

THE ESOPHAGUS

Congenital Anomalies of the Alimentary Tract, with Special Reference to the Congenitally Short Esophagus. Willis F. Manges and Louis H. Clerf. Am. Jour. Roentgenol. and Rad. Ther., May, 1935, **33,** 657–669.

These are divided into atresia, variation in lumen, length, or position, adventitious membranes, and diverticula. These conditions can be demonstrated by roentgenography, especially if they are kept in mind. Examination of the esophagus is stressed in the hernias of the stomach to demonstrate the length of the esophagus.

The bibliography of these conditions, the clinical signs, and many examples are presented.

S. M. ATKINS, M.D.

FOREIGN BODIES

The Diagnosis and Removal of Foreign Bodies from the Lower Air Passages. Charles K. Lewis. Jour. Tenn. St. Med. Assn., February, 1936, **29,** 48–50.

Foreign bodies in the air passages give rise to few symptoms after the initial phase. Such cases are diagnosed by changing physical signs, x-rays, or after bronchoscopy. Opaque objects may be visualized by x-ray or a distal atelectasis may suggest the location. Opaque objects bathed in pus or surrounded by granulation tissue may not cast a definite shadow on the plate.

In the discussion of this paper, Dr. W. W. Wilkerson, of Nashville, stated that cases of foreign body are occasionally misdiagnosed as bronchitis. Dr. Edgar L. Grubb, of Knoxville, used the diminished excursion of the diaphragm in incomplete bronchial obstruction as a diagnostic point. He suggests that films be made at the height of inspiration and expiration.

W. H. GILLENTINE, M.D.

A Non-medical Application of Radiology. Enrico Benassi. Archivio di Radiologia, 1935, **11,** No. 3–4, pp. 345–347.

Benassi points out how radiographs may be used to show, by the depth and angle of penetration of bullets, the distance from which a shooting took place.

E. T. LEDDY, M.D.

GALL BLADDER (NORMAL AND PATHOLOGIC)

Cholecystographic Diagnosis of Papillomas and Tumors of the Gall Bladder. Claude Moore. Am. Jour. Roentgenol. and Rad. Ther., May, 1935, **33,** 620–633.

This diagnosis can be made if it is kept in mind and films are taken in different planes, even in the Trendelenburg, if necessary. What appears a non-opaque stone may in the oblique view show the wall attachment of the tumor.

S. M. ATKINS, M.D.

Intrahepatic Gall Bladder. E. P. McNamee. Am. Jour. Roentgenol. and Rad. Ther., May, 1935, **33,** 603–610.

Intrahepatic gall bladder designates that condition in which the gall bladder is partially or completely buried in the liver substance. This is simply a developmental arrest and its diagnosis can be made preoperatively only by roentgenography. When filled with the dye, it is higher than normal and may be entirely overshadowed by the liver. The lower limit of the gall bladder may be on a level with, or above, the lower border of the liver. The diagnosis of such a condition will prepare the surgeon in case he is unable to see or feel the bladder when the abdomen is opened.

S. M. ATKINS, M.D.

The "Phrygian Cap" in Cholecystography: A Congenital Anomaly of the Gall Bladder. Edward A. Boyden. Am. Jour. Roentgenol. and Rad. Ther., May, 1935, **33,** 589–602.

This study represents a survey of the shape of the human gall bladder in some 200 series of cholecystograms collected during the last ten years, each series consisting of a large number of films made to test the reaction of a presumably normal biliary vesicle to one or more forms of physiologic experimentation.

Of the 165 individuals who have furnished this material, 18 per cent exhibited marked kinking of the gall bladder, either between body and infundibulum (24 cases) or between body and fundus (6 cases).

The first group, presumably arising early in development through extreme modelling of the fossa vesicæ felleæ, is believed to represent merely accentuation or minor variation of a normal pattern.

The second group, characterized by a fixed, folded fundus, is identified with the "phrygische Mütze" of German pathologists, first described by Bartel in 1916. The present study indicates that it is the most common congenital anomaly of the human gall bladder.

On the basis of new embryologic studies this anomaly is subdivided into two main types: the concealed or retroserosal type, caused by aberrant folding of the epithelial anlage of the gall bladder within the embryonic fossa vesicæ felleæ; and the serosal type, caused by aberrant folding of the fossa itself in early stages of development. In the second type the bend in the gall bladder is fixed by development of fetal ligaments, vestigial septa, or constrictions of the lumen following delayed vacuolization of the solid epithelial anlage.

Finally, on the basis of physiologic studies, exception is taken to the current European theory that the folded fundus of an otherwise normal gall bladder is a source of upper quadrant pain and, therefore, of "indisputable clinical importance."

S. M. Atkins, M.D.

The Roentgenologic Significance of "Milk of Calcium" Bile. Karl Kornblum and Wendell C. Hall. Am. Jour. Roentgenol. and Rad. Ther., May, 1935, **33,** 611–623.

"Milk of calcium" bile is a term used in connection with deposits occasionally encountered in the gall bladder consisting almost entirely of calcium carbonate. The roentgenologic manifestations are:

(*a*) Visualized gall bladder in roentgenograms without cholecystography or roentgenoscopic observation during a gastro-intestinal study.

(*b*) No change in the appearance of the gall bladder in the cholecystogram after the fatty meal.

(*c*) Persistence of gall-bladder shadow after cholecystography.

(*d*) Presence of stones in the cystic duct with a visualized gall bladder in a high percentage.

(*e*) Shadows unlike gallstones found in association with a non-visualized gall bladder during cholecystography.

The clinical story is not distinguishable from the ordinary gall-bladder one. Pathologically there is a marked similarity of these cases, namely, a gall bladder small, shrunken, and contracted. Only a few showed a distended gall bladder. The gall-bladder wall was thickened, and in some, marked fibrous changes were present; the mucous membrane damage was variable.

In addition to the calcium carbonate deposit there was usually a variable number of cholesterol or cholesterol bile pigment stones. The calcium carbonate deposit may occur in the form of milky fluid, as streaks of opaque material in a gelatinous mass, as a putty-like material, or as pure calcium carbonate. The color will depend on the presence or absence of bile.

S. M. Atkins, M.D.

GASTRO-INTESTINAL TRACT (DIAGNOSIS)

Some of the Radiologic and Clinical Aspects of Duodenal Diverticula. G. Bagnaresi and L. Bargi. Archivio di Radiologia, 1935, **11,** No. 3–4, pp. 280–324.

The authors report a study of 16 cases of diverticulum of the duodenum, mostly of an acquired type, two cases of false diverticulum due to abnormal angulation of the duodenum, and one case of probable filling of the ampulla of Vater. They discuss the importance of the mucosa of the duodenum penetrating into the diverticula to produce lacunar appearances. They also discuss the mechanism of diverticular stasis. Clinical diagnosis of diverticulum of the duodenum is impossible without x-ray examination. The differential diagnosis of the lesion is discussed from a clinical and roentgenologic point of view. Bagnaresi and Bargi point out the advantages of a preprandial administration of a barium suspension.

E. T. Leddy, M.D.

Total Left Dolicocolon: A Clinical and Radiologic Study. Giovanni da Empoli. Archivio di Radiologia, 1935, **11,** No. 3–4, pp. 239–248.

In the roentgenologic examination of the gastro-intestinal tract of a large series of cases da Empoli found that about 3 per cent of them had dolicocolon. He discusses the common and unusual symptomatology of this lesion and illustrates four cases of total left dolicocolon.

E. T. Leddy, M.D.

A Radiologic Study of the Intersegmentary Reflex of the Digestive Tract: The Gastro-appendiceal Reflex. Giuseppe Cola. Archivio di Radiologia, 1935, **11,** No. 3–4, pp. 217–230.

Cola discusses the mechanism of filling and emptying of the cecum and then describes the intersegmentary viscero-motive reflexes, particularly the gastro-colic and the gastro-appendiceal.

Filling of the stomach excites the motor activity of the stomach, leading to its partial or complete emptying.

This gastro-appendiceal reflex is present normally, and is especially frequent and active in cases of long appendix, colitis, and in some cases of chronic appendicitis.

E. T. Leddy, M.D.

Roentgen Study of the Gastro-intestinal Tract in Chronic Idiopathic Adult Tetany. Eugene P. Pendergrass and Bernard I. Comroe. Am. Jour. Roentgenol. and Rad. Ther., May, 1935, **33,** 647–656.

The case is reported of an adult who had chronic idiopathic tetany, with a most unusual gastro-intestinal roentgen appearance.

The features of the roentgen examination were as follows: *Stomach*—hypertonicity, hypermotility, and

hypoperistalsis. Pylorospasm was not conspicuous in any of the examinations. *Duodenum*—widely dilated. *Small intestine*—moderately dilated with considerable stasis and laking. Hypotonic, valvulæ conniventes not visualized. *Colon*—apparently normal in appearance.

The literature concerning the influence of the parathyroid and calcium metabolism on the gastro-intestinal tract is summarized.

S. M. Atkins, M.D.

GENITO-URINARY TRACT (DIAGNOSIS)

Bilateral Urinary Calculus. H. P. Winsbury-White. British Jour. Urol., September, 1935, **7,** 235–243.

This article is based upon an analysis of 233 cases of urinary calculi, in which series a bilateral incidence of 15.4 per cent was noted. The author discusses the clinical features, treatment, and operative prognosis in these bilateral cases and has attempted to classify them under the following headings: (1) large bilateral branched stone; (2) large stone on one side and small stone on the other; (3) calculi in one kidney and in ureter on the opposite side; (4) stone in both kidneys and both ureters; (5) stones in both sides of the upper urinary tract and also in the lower.

In the author's treatment of these conditions, he has attempted to rationalize his procedure and is to be complimented upon his clarity of vision in coping with this rather complicated phase of urinary surgery. The questions of which side, when, and how to operate on these types of cases are very well presented.

D. H. Pardoll, M.D.

GYNECOLOGY AND OBSTETRICS

Spondylolisthesis and Pregnancy. K. v. Dittrich and S. Tapfer. Zentralbl. f. Gynäk., April 13, 1935, **59,** 850–859. (Reprinted by permission from British Med. Jour., July 20, 1935, p. 12 of Epitome of Current Medical Literature.)

According to the authors, spondylolisthesis in the lumbo-sacral region would be more frequently detected were more attention paid to sacral backache and lateral roentgenograms more frequently taken. In etiology, beside congenital abnormalities of intervertebral articulations an important part is played by repeated trauma —as in the analogous conditions of Köhler's disease, Schlatter's disease, and osteochondritis of the lunate and navicular. In one of the authors' cases, as in other cases in the literature, listhesis of the fifth lumbar vertebra, which passed forward over the sacrum, necessitated Cæsarean section. The disease dated from an accident many years before, but pregnancy seemed to disturb its quiescence. It is concluded that the obstetrician should guard not only against interference by spondylolisthesis with labor, but also against its aggravation, during pregnancy, by the physiologic relaxation of ligaments near the pelvis. The experience of Dittrich and Tapfer, in correspondence with that of other recent observers and in conflict with text-book teaching, has shown that the difference between the intercristal and interspinous measurements is not necessarily unduly large, but that between the interspinous and intertrochanteric diameters is unusually small.

HEART AND VASCULAR SYSTEM

The Esophagus in Disease of the Heart and Aorta: Case Report with Roentgen and Postmortem Findings. J. B. Schwedel and E. B. Gutman. Am. Jour. Roentgenol. and Rad. Ther., August, 1935, **34,** 164–167.

A case is reported with clinical, roentgenologic, and postmortem findings of a female, aged 56 years, admitted to the hospital with a clinical diagnosis of hypertensive heart disease, cardiac enlargement, mitral insufficiency, relative tricuspid insufficiency with congestive heart failure. X-ray examination revealed marked enlargement of all chambers, particularly in the left auricle and left ventricle and the inflow portion of the right ventricle. The aorta showed marked fusiform dilatation and elongation of its ascending arch and descending portion.

The barium-filled esophagus was displaced to the left and posteriorly at the level of the base of the heart, apparently because of fixation to the adjacent posterior aorta. The lower segment of the esophagus was displaced posteriorly and to the left by the enlarged left auricle.

At postmortem the heart was found to be markedly enlarged, weighing 600 grams. There were numerous adhesions from the pericardium to the left auricle and to the great vessels at the base. Both ventricles and both auricles were considerably enlarged and the mitral ring was calcified. The ascending arch showed thickening, inelasticity, and dilatation, with numerous atheromatous plaques with and without calcification. The descending portion of the arch showed thin fibrous adhesions extending to the esophagus, these adhesions accounting for the rather marked displacement to the left posteriorly of the mid-portion of the esophagus.

J. E. Habbe, M.D.

HEMOPHILIA

Articular Changes in Hemophilia. C. E. P. Buus. Acta Radiologica, 1935, **16,** 503–517.

Illustrations are given of the roentgenologic findings in two cases of hemophilia and the characteristic articular changes are discussed. These are listed as (1) sharply defined marginal erosions; (2) narrowing of interarticular space; (3) subchondral rarefactions; (4) rarefaction in bone tissue unconnected with joint surface; (5) irregular joint surface; (6) opacities in soft tissues corresponding to the capsule; (7) considerable destruction of the joints with resulting subluxation. In severe cases the end-result is often ankylosis. The patho-anatomical changes produced are reviewed in the light of the work done by Freund, Reinecke, Wohlwill, and Key. Difficulties of differential diagnosis in cases of articular disease resembling hemophilia are considered.

E. M. Shebesta, M.D.

HEMORRHAGE

Benign Uterine Hemorrhage, with Special Consideration of Radiation Therapy. Henry Schmitz. Am. Jour. Roentgenol. and Rad. Ther., June, 1935, **33,** 819–822.

Uterine hemorrhage should not be treated by radiation except after corroboration of the clinical diagnosis, by diagnostic currettage or biopsy. Concerning the frequency of uterine hemorrhages, the writer found 23.89 per cent due to malignant disease and 76.11 per cent to benign lesions, the latter being caused by (1) extra-genital diseases; (2) accidents of pregnancy, labor, and puerperium, and (3) physiologic or anatomical-pathologic changes in the genital organs.

Hemorrhages resulting from anatomical pathology obviously require medical or surgical treatment. The only exceptions are occasioned by bleeding uterine myomas and endometriomas, which may become symptomless and disappear entirely after temporary or permanent cessation of ovulation by means of irradiation.

Treatment of benign primary uterine and ovarian hemorrhage is medical, surgical, or radiological. The number of hypermenorrheas in which radiation treatment was indicated was 20 of 73 cases of primary functional uterine bleeding, or 27.39 per cent. The number of polymenorrheas treated with radiation was 3 of 30 primary ovarian dysfunction, or 10 per cent. The number of metrorrhagias treated with radiation was 22 of 36 cases of persistent follicle or hemorrhagic metropathy, or 61 per cent. Hence in a total of 149 functional uterine and ovarian hemorrhages, 45 cases (or 32 per cent) were subjected to radiation therapy. Bleeding myomas produced 62 per cent of the cases of uterine hemorrhages of which 16 (or 17.8 per cent) were irradiated.

The good end-results of radiation treatment in the functional uterine hemorrhages numbered 316 in a total of 322 cases, or 98.14 per cent, with a mortality of 0.66 per cent.

The good end-results of radiation treatment of bleeding uterine myomas numbered 103 in a total of 109 cases, or 94.5 per cent. Mortality was 1, or 0.86 per cent. If the mortality of the sarcoma occurring three years later is included, the rate is 1.72 per cent.

The roentgen dose for the production of permanent amenorrhea is about 400 r with back-scattering measured in the mid-pelvis and attained through two fields, one superpubic and one sacral; for the production of temporary amenorrhea the dose is 25 per cent less than the castration dose, or 300 r, with back-scattering attained in the mid-pelvis.

Multiple myomas are always associated with subserous and submucous myomas and radiation treatment is contra-indicated.

Of the 322 cases of functional uterine bleeding, 290 were treated with radium and 24 with roentgen rays, whereas of the 109 myomas, 85 were treated with radium and 24 with roentgen rays.

J. E. Habbe, M.D.

HODGKIN'S DISEASE

Roentgen Therapy in Hyperplastic Blood Dyscrasias: New Technic for Myeloid and Lymphatic Leukemia, Polycythemia Rubra Vera, and Hodgkin's Disease. Heinz Langer. Am. Jour. Roentgenol. and Rad. Ther., August, 1935, **34,** 214–231.

The writer believes, as the result of certain experimental work recorded in the literature to the effect that over-irritation or over-stimulation of the vegetative nervous system influences the blood-forming organs to over-production, and because of results obtained by his method of treating Hodgkin's disease and polycythemia rubra, that treatment of leukopoietic tissues in blood dyscrasias may logically be carried out by means of radiation of the sympathetic nervous system ganglia rather than by applying radiation directly to enlarged gland masses, the spleen, or the bone marrow.

The fields for treatment over the vegetative nervous system are as follows: (1) With the head of the patient turned so that the neck and temporal region are in the same plane, a field is outlined to include the hypothalamus and the wall of the third ventricle and the three cervical sympathetic ganglia, this field being 7 by 17 cm.; (2 and 3) the spine posteriorly over the right and left sides obliquely from the level of the spinous process of the first down to the seventh dorsal vertebra, these fields again being about 7 by 18 cm.; (4 and 5) fields over the spine on the right and left sides obliquely beginning at the level of the seventh dorsal spinous process and extending to the second lumbar spinous process, and (6 and 7) oblique fields on the right and left sides over the lumbosacral spine beginning at the second lumbar spinous process and extending through the sacral region. The author usually gives from 150 to 250 r over two fields per day, subsequent treatments being given at one- to two-day intervals until a maximum of 500 r per field has been given. While it is emphasized that relatively small doses are usually sufficient, the author also points out that some of the most beneficial results were obtained in those patients who experienced the most severe roentgen sickness.

Such sympathetic nervous system radiation regularly produced beneficial reaction in the blood count. These observations were made on 17 cases of myelogenous leukemia and 13 cases of lymphatic leukemia. A small number of cases of polycythemia rubra vera and Hodgkin's were also treated by this method.

J. E. Habbe, M.D.

INFLAMMATORY DISEASES

Radiotherapy of Inflammatory Affections. I. Solomon and P. Gibert. Presse Méd., Aug. 7, 1935, **43,** 1251–1253. (Reprinted by permission from British Med. Jour., Nov. 23, 1935, p. 80 of Epitome of Current Medical Literature.)

The authors call attention to the value of x-ray treatment of furunculosis of the face and skin; tuberculous abscesses; certain inflammations of the mouth, phar-

ynx, nasal sinuses, and female genitalia, and some anorectal conditions. Small doses ranging from 100 to 200 r are employed, the smaller being advisable in the more acute conditions. The nature of the filter used does not seem to matter, but the field of irradiation must extend far outside the inflammatory area. If no satisfactory reaction is observable in from four to eight days, the irradiation should be repeated. Should two repetitions prove ineffective nothing will be gained by trying higher doses. The authors agree that the bactericidal effect of x-radiation is small, and they do not attribute the good results they have obtained to a general immunizing response. They conclude that the x-rays induce a local alkalosis, dilatation of the blood capillaries, and better circulation of the lymph, all of which have a curative action on the local inflammation, with no prophylactic value as regards possible recurrences. They believe that this line of treatment will become popular if it is realized that the dosage must be kept within safe limits.

Radiotherapy for Acute and Chronic Inflammatory Conditions. A. U. Desjardins. Texas St. Jour. Med., February, 1936, **31,** 616–622.

The author uses doses of roentgen rays representing less than half the skin tolerance dose in the treatment of acute inflammation. He reports spontaneous resolution when such lesions are treated early.

Furuncles, carbuncles, cellulitis and phlegmon, onychia and paronychia, abscess, acute adenitis, parotitis, erysipelas, and gas bacillus infections have been treated successfully. Some cases of unresolved pneumonia are reported from the literature, with favorable results following irradiation. Suppuration in parotitis is decreased 90 per cent after irradiation therapy (20 cases). These lesions were irradiated over the affected region and a wide apparently unaffected region surrounding the inflammation with from one-third to one-half of an erythema dose of roentgen rays of medium wave length, generated at a potential of from 120 to 140 peak kilovolts and filtered through 4 millimeters of aluminum (200 to 350 roentgens). Chronic inflammations require from 250 to 500 roentgens, generated at a potential between 130 and 140 kilovolts, and filtered through from 4 to 6 millimeters of aluminum. Results for this type of case are uncertain and treatments must be repeated over a longer period of time. Tuberculous adenitis, for instance, must be treated every three or four weeks for from three to twelve months. Results are indicated by the disappearance of inflammation, and small caseous areas become calcified. Actinomycosis, trachoma, and chronic infectious arthritis are benefited when irradiation is used with other measures.

Experimental work has shown that all lymphoid structures begin disintegration within 15 minutes after irradiation. Phagocytosis of the chromatin débris then begins. The author postulates that the death of these cells releases some protective substance that the cells ordinarily contain or elaborate to combat the infection. A large amount of this substance affects the course of the infection favorably.

Points in favor of this argument are: (1) Rapidity of recession of irradiated inflammations corresponds to the rate at which normal leukocytes are known to be affected by exposure to rays; (2) no ill effects have been known to follow irradiation; (3) in chronic infections, x-ray is most beneficial when cellular infiltration predominates over an increase in connective tissue in the lesion.

W. H. Gillentine, M.D.

THE JOINTS

Solitary Articular Chondroma. (Chondromatosis of Articulations.) W. Theler. Fortschr. a. d. Geb. d. Röntgenstrahlen, 1935, **52,** 1–17.

This paper presents a review of 38 cases of solitary articular chondroma collected in the Roentgen Institute of the University of Zürich. One of these patients was less than 20 years of age; 18 were between 20 and 40; 19 over 40 years of age. Males numbered 33, females, five. In 29 instances only one articulation was involved; 17 times the elbow was afflicted (15 times the right, twice the left); 13 times (9 mono-articular, 4 di-articular) the knee; 8 times the hip (5 mono-articular, 3 di-articular). In knee and hip joints, there is no particular preference for either side. Chronic arthrosis is found quite frequently secondary to and induced by chondroma. Arthrosis deformans and solitary articular chondroma must be regarded as two different disease entities which, however, produce similar symptoms quite frequently.

Roentgenologic investigation should furnish reliable information concerning the etiology of the disease. It is assumed that detached cartilaginous anlage in the synovial lining and a chondrogenous disposition represent the etiology of this disease process, while infection, trauma, and metaplasia of synovial cells into cartilaginous cells are rejected. Mechanical influences are considered as of merely secondary importance in the development of the disease. The designation of "malignant articular chondromatosis" of Kienböck is rejected. Most conservative therapy is recommended.

H. A. Jarre, M.D.

THE LUNGS

Acute Influenza Pneumonitis. Albert Bowen. Am. Jour. Roentgenol. and Rad. Ther., August, 1935, **34,** 168–174.

The respiratory form of influenza, or so-called "flu," has been rather prevalent in mild forms in Hawaii. In an effort to control the spread of the infection in the Army, all soldiers who show a rise of temperature to 100 degrees are hospitalized and routine roentgenographic studies of the chest are carried out. In all positive cases the studies are repeated until resolution has taken place. Ordinarily this occurs within from seven to ten days. No definite cause has been found to explain the frequency of pneumonitis in the influenzal cases occurring in Hawaii; however, from 5 to 25 per

cent of these cases in army hospitals do develop a pneumonitis. Toward the end of the 1934 epidemic, pulmonary complications showed marked increase both in number and severity from mild pneumonitis through bronchopneumonia to typical influenza pneumonia involving all lobes. There were no fatalities. "Influenza pneumonitis" is a term recommended by the author to describe a localized bronchopneumonia which, in his opinion, constitutes a distinct clinical picture. The roentgen appearance is that of a confluent mottled band of rounded area, usually of homogeneous moderate density in the central portion, with borders fading into the normal lung. This condition is usually basal though it has been seen in the upper lobes. Clinically, the condition probably passes for an acute bronchitis but a roentgenogram will always show the presence of an exudative process. None of the cases of influenza pneumonitis in Hawaii had hemorrhagic sputum. The radiographic evidence of resolution and recovery has been found more dependable than the clinical. In some cases the film appearance suggests nodose tuberculosis. In these, serial studies are helpful in arriving at a differential diagnosis.

J. E. HABBE, M.D.

The Treatment of Pulmonary Cavities. Louis H. Fales and E. A. Beaudet. Am. Jour. Roentgenol. and Rad. Ther., May, 1935, **33,** 636–646.

Based on a study of 90 patients of middle age showing cavities, the conclusions were drawn that cavities may be divided into the exudative or young, productive or moderately old, and fibrotic or old.

The exudative respond most favorably to conservative treatment (66 per cent healed) and the fibrotic to surgical treatment.

If after six or eight months of conservative treatment cavities show no tendency to heal, then some mechanical intervention should be instituted. Phrenicotomy or phrenicectomy is recommended as the first aid to rest in the treatment of the exudative and productive when they show no tendency to heal. When this fails, artificial pneumothorax is attempted and thoracoplasty is available for those which have not responded to other methods.

Although the authors stress the fact that rest or hospital care is the most important factor in the healing of cavities, they also advise careful watching by frequent roentgenograms and institution of mechanical compression promptly when indicated.

S. M. ATKINS, M.D.

NEVI

Pigmented Moles and Their Treatment. H. Ford Anderson and C. Augustus Simpson. Am. Jour. Roentgenol. and Rad. Ther., January, 1935, **33,** 54–58.

The possibility of malignancy in this condition is 1 in 1,500. Although trauma is the causative factor in causing these benign lesions to become malignant, nevertheless, many of them are exposed to trauma for years without any change, and thus the real cause of malignant change is not definitely known. The authors believe infection accompanying irritation is the factor.

As a precautionary measure they advise the removal of pigmented moles when located in areas easily irritated, either by excision, x-ray or radium radiation or desiccation and curettage from without in; all of the above to include a zone of healthy tissue around them. The x-ray radiation method consists of a hypermassive dose given at one sitting and producing a slough. None of the benign lesions removed has recurred. Biopsy is inadvisable.

In the proven malignant cases which up to now have resulted in 99 per cent surgical failures at the end of five years, radiation therapy in hypermassive doses including the drainage area is undoubtedly the superior method, and the prognosis should be better with the superior methods now at hand.

S. M. ATKINS, M.D.